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BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. XXII¹

THREE NEW GENERA FROM POLYNESIA AND MELANESIA

By ERNST MAYR

EDITHORNIS, new genus

Wing with ten primaries, second shorter than tenth; fourth, fifth, and sixth longest, subequal; secondaries soft, decomposed, slightly shorter than tenth primary.

Tail very short; rectrices hairlike, slightly longer than upper tail-coverts, equal to length of lower mandible from gape, or to the outer toe without claw. Wing-tip very short, about half the length of hallux and claw.

Bill strong, from gape to tip of maxilla slightly longer than head, about two-thirds of tarsus; bill laterally compressed, at nostrils more than twice as high as wide; maxilla and mandible curved; longitudinal groove on the sides of the mandible, two parallel grooves at the base of the gonys separated by a narrow ridge; large gray-blue horny frontal shield, about one and one-half times as long as the red part of the maxilla; the posterior edge of shield straight, not rounded; culmen and shield together shorter than tarsus; nostrils large, oval, not pervious; nasal groove short, broad, shallow and curved; lores and lower and posterior parts of circumocular space covered with short, scattered, brushlike feathers; eyelid and strip of skin (from gape under the eye to the postocular region) bare.

Legs and feet slender and long; lower third of tibio-metatarsus bare; tarsus about equal to middle toe plus claw, two-fifths of the length of the wing; plantatarsus scutellate on uppermost part, reticulate on lower part; toes long and slender, not webbed.

GENOTYPE.—*Edithornis silvestris*, new species.

Edithornis silvestris, new species

TYPE.—No. 227850, Amer. Mus. Nat. Hist.; ♂ ad.; San Cristobal Island, British Solomon Islands; December 4, 1920; E. Mayr, W. F. Coultas, and W. J. Flyardam.

Breast, throat, sides of head, crown and hind neck dark bluish slate-color, almost blackish on chin and sides of face; forehead covered with shield; scapulars, interscapulium, wing-coverts, and secondaries brown-black with an olive tinge; lower flanks, under wing-coverts, under tail-coverts, thighs, lower back, and rump dull (brownish) black; no light bars or stripes anywhere on the body.

"Iris chocolate, feet and bill bright scarlet, shield dark gray-blue, testes small; weight 450 grams."

Wing, 149 mm.; tail, 40; culmen and shield, 56; maxilla from gape, 41; tarsus, 60; middle toe with claw, 59; outer toe with claw, 46. ‡

¹Previous papers in this series comprise American Museum Novitates, Nos. 115, 124, 149, 322, 337, 350, 356, 364, 365, 370, 419, 459, 486, 488, 499, 502, 501, 510, 520, 522, and 531.

This remarkable new rail stands out among the numerous discoveries of new species by the Whitney South Sea Expedition. It is a type quite by itself and apparently has no close relative. Of all the rails known to me, the extinct (?) Samoan rail *Pareudiastes* shows the greatest likeness to *Edithornis*.

It gives me pleasure to name this genus in honor of Mrs. George F. Baker, Jr., who has shown so much interest in the progress of the Whitney South Sea Expedition.

Edithornis differs from *Pareudiastes* by having bill and feet much more developed. The frontal shield is larger and the feathering on the sides of the head is different. Tarsus and feet are comparatively much longer.

I can say very little about the habits of this bird, which was collected by one of our native hunters. According to them, this bird, which they call "Kia" (pronounced Ke'ka), lives in the dense undergrowth of the mountain forest. Apparently it does not fly very much, if at all, and is hunted by the natives with dogs. The bird seems to be very rare, as we did not succeed in getting a second specimen in spite of all the inducements I offered, realizing at once the value of this new genus.

The locality where the bird was discovered is the village Húno gáraha or Hanagáraha, in the center of San Cristobal Island, about ten to twelve miles south of Wanoni Bay. The village is at an altitude of about 1900 feet, but the mountains in the vicinity go up to almost 4000 feet. The whole region is covered with primeval mountain forest intermingled with native plantations and some secondary growth. Numerous brooks and creeks cut deep in the steep slopes of the mountains, but no lakes, ponds, or swamps were seen by us or reported by the natives. Nevertheless *Amaurornis olivaceus* and *Hypotaenidia philippensis* were found at the same locality, two rails which are frequently found in the Solomon Islands far away from water. They seem particularly fond of the dense undergrowth in secondary formations. *Edithornis*, however, is probably more a true forest bird than either of the two other species.

The other bird life was characteristic of the hills of the Solomon Islands and contained several other new species and subspecies belonging to the genera *Petroica*, *Phylloscopus*, *Rhipidura*, *Seriornis*, and *Oreocornis*.

CICHLORNIS, new genus

Bill long, slightly curved, without marked notch on the maxilla, width equal to height at the nostrils; nostrils oval, situated on the lower edge of a shallow nasal groove, which is partly covered by an operculum; feathering of the forehead short,

not very stiff, reaching to the posterior margin and the middle of the upper edge of the nostril; gonys narrow; rectal bristles very weak, hardly visible

Feet very strong and powerful, with long toes; tarsus long, longer than culmen, about two-fifths of the length of the wing, covered with large scales; toes long, middle toe with claw almost as long as tarsus, hind toe with claw (21 mm) as long as culmen from base.

Wing short and round; fifth and sixth primaries longest, subequal; distance between first and longest primary (24 mm) one-third of the length of the wing, thus shorter than tarsus; second primary about the length of secondaries; distance between longest secondary and longest primary less than half the culmen

Tail long and strongly graduated; shortest tail-feather less than half the longest; tail-feathers narrow with strong, almost spiny shafts; tail in worn condition very pointed

Plumage hard and compact, feathers on rump and flanks not dense nor elongated; no crest.

GENOTYPE. *Cichlornis whitneyi*, new species.

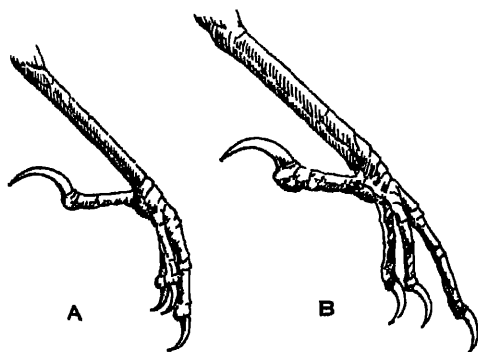


Fig. 1. A, foot of *Megalurulus*, B, foot of *Cichlornis* (tarsus heavier, toes more elongated). Natural size.

DISCUSSION OF RELATED GENERA

Megalurulus of New Caledonia apparently is the nearest relative of *Cichlornis*. I have seen only one specimen of *M. mariae* Verreaux and its characters do not agree in every respect with the ones given by Sharpe in the key of the Timeliidae, 'Cat. Birds,' VII, pp. 324-327. He says that in *Megalurulus* the distance between primaries and secondaries is as great as the length of the culmen, while in my specimen it is decidedly less. *Cichlornis* agrees with *Megalurulus* in the texture of the plumage, in the absence of a tuft of feathers on the lower back, in the shape of the nostril, the shape of the wing and the pattern of coloration; it differs, however, in its stronger bill and feet, in its much longer toes, in a shorter tail and in the stronger shafts of the tail-feathers.

The genera *Ortygocichla* and *Trichocichla*, although widely separated from *Megalurulus* by Sharpe in 'Cat. Birds,' VII, and in the 'Hand-list,' IV, seem to me to be rather closely related to *Megalurulus* and to *Cichlornis*. Both groups agree in the shape of the bill, the powerful feet, the length of the tail, the shape of the wing, and also the general color-pattern. The two groups differ, however, in the shape of the nostril, in the strength of the bristles, in the stronger fusion of the scutes on the tarsus, in the broader and softer tail-feathers, in the softer plumage generally, and in having a large tuft of soft, elongated feathers on the lower back and rump. The characters which are supposed to distinguish *Trichocichla* generically from *Ortygocichla* are of doubtful value. Reichenow (1891, Journ. Ornith., XXXIX, p. 130) lists three: the shape of the wing, the presence of bristles, and the scutellation of the tarsus. If I can conclude from a single specimen of each genus, then neither one of these three characters is of any value. I do not see the slightest difference in the wing, the bristles in *Ortygocichla* are as little developed as in *Trichocichla*, and the scutellation of the tarsus is equally vague in both "genera." Furthermore, I do not see any marked difference between the two "genera" in the development of the dorsal feather-patch, a point mentioned to me (*in litt*) by Prof. Stresemann as possibly distinctive. It would, therefore, be advisable to put *Trichocichla* in the synonymy of *Ortygocichla*. The distribution of such a genus (New Britain and Viti Levu) is certainly very paradoxical.

Cichlornis whitneyi, new species

TYPE.—No. 224308, Amer. Mus. Nat. Hist.; ♂ ad. (testes "large"); Santo Island, New Hebrides; December 8, 1926; R. H. Beck.

Crown and narrow stripe extending from the gape under the eye to the upper ear-coverts, dark brown (between R. XXIX and mummy brown, R. XV); back, scapulars, and lesser wing-coverts lighter brown (about Prout's brown, R. XV), rump and upper tail-coverts slightly more rufous; lores, supercilium, broad post-superciliary stripe, throat, breast, and middle of abdomen ochraceous (between ochraceous tawny and ochraceous orange), richer on the breast and on the sides of the throat, paler in the middle of the throat, and paler and duller on the abdomen; lower flanks, crissum, thighs and under tail-coverts more brownish (near snuff brown, R. XXIX); tail-feathers brown with shafts blackish; wings dark brown, edges of wing-feathers cinnamon or light brown; axillaries and edges of under wing-coverts ochraceous.

"Iris brown, bill black, lower mandible more light colored, feet black."

The measurements of the only known specimen of this species are: wing, 72 mm.; tail, 70 (+X); culmen from base, 21, exposed 17, from anterior edge of nostril 12; tarsus, 28, middle toe with claw, 27; hind toe with claw, 21; distance between first and longest primary, 24; between longest primary and secondary, 8; and between longest and shortest tail-feathers, 38.

Very little is known about the habitat and life history of this species. Mr. Rollo H. Beck has kindly supplied the following information: "The country where I collected this bird was very steep—Primeval forest on rugged canyons at about 2500 feet elevation. Two or three others were heard, but kept concealed in the dense underbrush. As it happened, the trail into the interior of the island dipped sharply downward after 2400 feet was reached and the birds were found only for a short distance along the higher part of the trail examined. Probably the interior of the island, which is much higher, will yield more specimens when some one outfitted properly to make an extended stay penetrates into the high country. Our anchorage was not satisfactory for any length of time, so we had to return to the ship each night. We were anchored at a small village near the southwest end of the island."

MALACOLESTES, new genus

Bill strong, curved, with a distinct notch in the maxilla; nostrils small, round, partly covered by feathers and bristles; rictal bristles well developed, long; culmen longer than hind toe and claw.

Feet strong; tarsus covered with large scutes.

Wing pointed, wing-feathers also pointed, not round; first primary long; distance between longest primary and secondary less than length of culmen. Second primary equal in length to secondaries or longer; fifth primary longest.

Tail short, shorter than wing by more than the length of the culmen; tail-feathers slightly pointed.

Plumage very soft and silky; the body plumage, particularly on flanks and back, has an almost downy character.

(Genotype). *Rectes leucorossus* Hartlaub and Finsch.

This bird has been placed by the various authors into different genera usually with the remark that really a new genus should be created for this rather aberrant form. Most frequently it was included into *Rhertes* (= *Pitohui*) and *Pinarolestes* (= *Myiolestes*) *Pitohui*, however, differs by its rounder wing, its larger nostrils which are not covered by bristles, its much longer and stronger tail, and its much harder plumage. *Myiolestes* differs by its rounder wing with a much shorter first primary, its weaker bill and its much harder plumage.

After I had worked out this description, I received field notes from Mr. W. F. Coultas, the collector of this bird, which fully confirm my opinion that it has no relationship to either *Pitohui* or *Myiolestes* of New Guinea. Mr. Coultas writes:

"This bird is called 'Tu Tau' by the natives of the Palau Islands, meaning the 'Morning Bird,' because his sweet little carol heralds the

approach of day. He never sings during the heat of the day, and in the evening, if one is close enough one can hear him crooning himself to sleep—more like our American Brown Thrasher who holds a quiet little song festival with himself just at dusk. This bird lives almost entirely on the ground and occasionally on very low bushes. He is usually found scratching around among the dead leaves for mollusca, worms, seeds, etc. He is one of the few real song birds it has been my pleasure to hear in the tropics."

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A NEW SUBGENUS OF *PLECOSTOMUS* FROM BRAZIL

By FRANCESCA LAMONTE

CARINOTUS, new subgenus

Dorsal I, 9, originating slightly in front of the ventrals, separated from the supra-occipital by four scutes. A naked area behind temporal plate, slightly larger than first scute of lower lateral series. Body flat below from anal to caudal. Between dorsal and adipose two pairs of scutes, followed by five azygous scutes, the latter forming a rising keel to adipose spine.

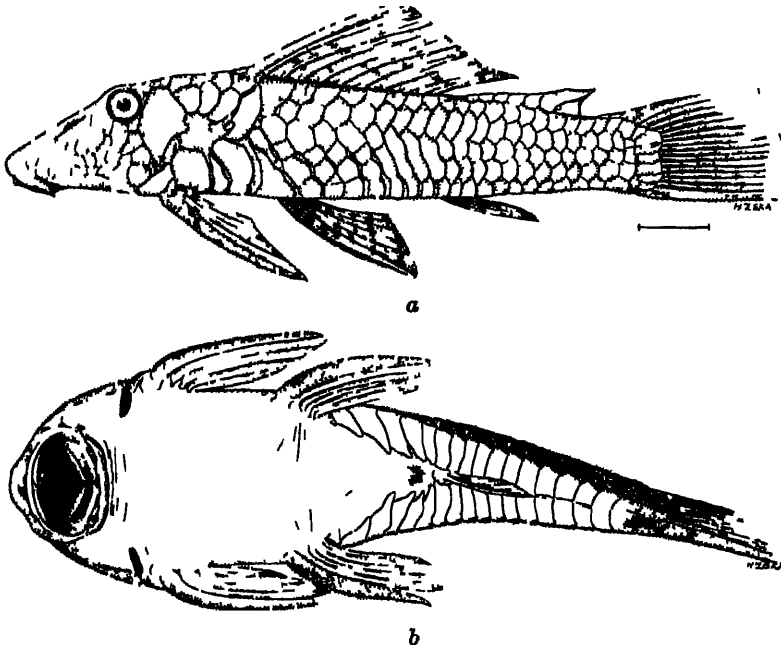


Fig. 1. *Plecostomus (Carinotus) carinotus*, new species
a, lateral view; b, ventral view.

Body oblong; first scute of lower lateral series posterior to clavicle and temporal plate, separating the second entirely from the latter; lower surface of head and abdomen entirely naked; snout with naked margin. Opercle and interopercle not independently movable, without marginal bristles. Mouth large, premaxillaries slightly

longer than dentaries and opposed to them; teeth numerous, hooked inward, long, very slender, thick-set, bifid, forming a single series in each jaw, about $\frac{9}{10}$ on each mandibular ramus. Anal I, 4. Adipose fin represented by a spine and a membrane attaching it posteriorly to the caudal peduncle.

TYPE.—*Plecostomus carinotus*, new species.

***Plecostomus (Carinotus) carinotus*, new species**

The type, our only specimen, Number 11911, American Museum of Natural History, was collected by Dr. O. Couto de Aguirre, in the Rio Doce, Estado do Espírito Santo, eastern Brazil. It measures 235 mm. standard length.

The head is measured from the tip of the snout to the posterior margin of the temporal plate.

Depth of body, 5.4 in its length; length of head, 3.6. Length of snout, 1.6; diameter of eye, 6; interorbital width, 3 in head. Length of mandibular ramus, 1.3 in the interorbital width. Barbel rudimentary. Snout broad, rounded, median ridge before nostrils, supraorbital margins raised; supraoccipital flat; temporal plates not keeled. Scutes spinulose, only carinate on posterior ventral edges and before adipose fin; 24 in longitudinal series, counting as the first one the scute posterior to clavicle and not including plates covering bases of caudal rays. Between dorsal and adipose 2 pairs, followed by 5 azygous plates which form a rising keel terminating in the adipose spine, 8 between anal and caudal. Supraoccipital bordered posteriorly by three unequal scutes. Lower surface of head and abdomen entirely naked. Dorsal I, 9 (mutilated), the first ray not as long as head and not reaching adipose when laid back; length of base of dorsal more than its distance from tip of spine of adipose. Anal I, 4. Pectoral I, 5, extending to anterior third of ventral which is I, 5. Caudal mutilated.

Color in alcohol yellowish tan, slightly darker above and on head than below; dark blotches on head scutes and on those between supraoccipital and dorsal; fins all crossed by rows of darkish spots; dorsal rays with dark tips.

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PACHYPANCHAX, A NEW GENUS OF CYPRINODONT FISHES FROM THE SEYCHELLES ISLANDS AND MADAGASCAR

By GEORGE S. MYERS

Further studies¹ of the funduline cyprinodont fishes show the existence of a hitherto unrecognized genus in the Seychelles Islands and Madagascar. Pending publication of a revision of the African and Asiatic genera, it seems best to place the new genus on record

PACHYPANCHAX, new genus

GENOTYPE.—*Haplochilus playfairi* Gunther, 1866.

Maxillary near its end closely bound down to the preorbital region by skin, and only slightly movable. Lip-rietus fitting up into a right-angled notch before eye. Proximal area of caudal fin, more than half-way to margin, closely and finely scaled; the caudal scales are in straight even rows, one scale in width, diminishing in size and diverging from each other as they proceed outward; each series covers the interspace between two of the caudal rays. Haemal arches not expanded for the extension of the coelom and air-bladder into the caudal region. Dorsal fin set far back. Caudal fin rounded. Habitus similar to that of *Panchax* and *Epiplatys*, but more chubby.

Pachypanchax playfairi differs from *Panchax* and *Epiplatys* and agrees with *Aphyosemion* and *Nothobranchius* in the attachment of the maxillary to the preorbital, although in habitus it approaches the first two. It has recently been referred to *Panchax*, from which it differs not only in the maxillary but also in the unexpanded haemal arches. *Pachypanchax* differs from all other African and Asiatic genera in the peculiarly scaled caudal fin. In this it approaches the recently described *Austrofundulus* from Venezuela (Myers, Proc. Biol. Soc. Wash., XLV, 1932, p. 159), which, in common with all the other Neotropical Rivulini, differs from the Old World genera in having the maxillary fixed partly or wholly behind the preorbital.

Pachypanchax playfairi is known from the Seychelles, from which source I have examined specimens in The American Museum of Natural History through the courtesy of Mr. J. T. Nichols. Aquarists have lately obtained living material in Zanzibar. Two other species appear to be referable to the genus, although I have not seen specimens. These are *Pachypanchax omalonotus* (Duméril, 1861), from Nossi Bé, Madagascar, and *Pachypanchax sakaramyi* (Holly, 1928), from Sakaramy, Madagascar.

¹See Myers, 1931, Hstanf. Univ. Pub., Biol., VI (3), etc

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NOTES ON AMERICAN SPIDERS OF THE FAMILY THOMISIDÆ

By W. J. GERTSCH

Considerable confusion has existed as to the number of species of *Tibellus* in the United States and their identification with spiders described from Europe. In 1847 Hentz described a species from Georgia, placing it in the genus *Thomisus* and naming it for its discoverer, Thomas R. Dutton. As early as 1880 Keyserling correctly identified Hentz's species and redescribed it, giving good figures of the palpus and epigynum and comparing it with *Tibellus oblongus* (Walckenaer), a European species. On the basis of specimens from Mount Washington and Colorado he recorded this latter species from the United States. The nomenclatorial vicissitudes of our spiders of this genus since that time have been unique. In a supplementary plate in the reprint of Hentz's 'Spiders of the United States,' published in 1875, Emerton had already figured the palpus of a specimen of *Tibellus* from Oklahoma, in which the embolus was much inflated basally and the whole deeply grooved, as the *Thomisus duttoni* of Hentz. Later (1892) this same author, apparently not attaching specific import to the quite different embolus, though he recognized the anatomical disparity, figured as *Tibellus duttoni* (Hentz) the common northern species in which the tube is longer and comparatively slender. Probably on the basis of these figures of Emerton and some specimens of this latter type, Simon in 1895 in his 'Histoire Naturelle des Araignes' synonymized *T. duttoni* with *oblongus* and recorded it and *T. propinquus* from the United States. Both of these had been treated in his 'Arachnides de France' in 1875. Kulczynski, in 1908, recognizing that Simon had erred in his identifications, showed *Tibellus propinquus* Simon to be the true *T. oblongus* of Walckenaer and *oblongus* of Simon to be synonymous with *T. maritimus* (Menge). On the basis of Emerton's first figure he recorded this latter species, also found in Europe, from the United States. Strangely, Petrunkevitch in his 'Synonymic Index Catalogue' listed only *Tibellus oblongus* from the United States.

A study of numerous collections of these spiders from the United States shows that there are at least four species in this country. *Tibellus*

oblongus (Walekenae) is found from coast to coast in North America and from the southern states far north into Canada. It is widely distributed in Europe. *T. maritimus* (Menge) has the same distribution but is comparatively rare throughout its range. Both these species are replaced to an extent in the southeastern states by *Tibellus duttoni* (Hentz) and in the southwestern states by *Tibellus chamberlini*, new species, both being more slender forms with longer legs. A fifth species of the genus is found in Cuba and is herein described from a single female example. Three other species, from Mexico, Paraguay, and Guiana respectively, though imperfectly known, bring the number of species in the Americas to a total of eight.

I am pleased to acknowledge the loan of much material for determination and distributional data from Dr. Chamberlin of the University of Utah, Professor Crosby of Cornell University, and Professor Chidester, Albion College, Michigan. To Miss E. B. Bryant of the Museum of Comparative Zoölogy I am indebted for the loan of specimens, drawings, and much help in the involved synonymy of the group.

TIBELLUS E. Simon

1875, 'Les Arachnides de France,' II, p 307.

Thomisid spiders of the subfamily Philodrominae

Integuments with plumose hairs Cephalothorax longer than broad, the width at the front much less than half the width at the widest point. Eyes in two recurved rows, all small, the anterior row much shorter Median ocular quadrangle as broad as or broader than long, narrowed in front, the eyes subequal, smaller than the anterior laterals, which are always smaller than the posterior laterals. Lower margin of the furrow of the chelicera unarmed, the upper with two teeth Labium comparatively short, truncated or rounded at the distal end. Leg formula 2413, very long, the tarsi scopulate, the claws of normal size. Palp of the male with the tibial apophysis much reduced or wanting. Abdomen very elongate, the sides nearly parallel.

This genus has close affinities with *Apollophanes* (Cambridge and Thanatus C. Koch. From *Apollophanes* it differs in its narrower cephalothorax, in the greater distance between the posterior median and posterior lateral eyes, and in having the last pair of legs longer than the first pair. From *Thanatus* it differs in that the anterior median eyes are much nearer together than to the laterals and in the longer cephalothorax, but both have the fourth leg somewhat longer than the first.

KEY TO MALES

- | | |
|--|--------------------------------------|
| 1.—Anterior tibiae with three pairs of spines beneath. | 2. |
| Anterior tibiae with four pairs of spines beneath | 4. |
| 2 —Tibia with a distinct apophysis. | <i>T. punctulatus</i> (Taczanowski). |
| Tibia with only a slight apophysis or with none. | 3. |

- 3 Embolus basally much inflated, grooved *T. martinus* (Menge)
 Embolus straight, not much thicker at base, distally grooved *T. oblongus* (Walckenaer)
- 4 Tibia with a conspicuous black maculation at base on dorsal surface *T. paraguensis* Simon.
 Tibia without such a marking . . . 5
- 5 Embolus distally somewhat hooked (southeastern United States) *T. duttoni* (Hentz).
 Embolus straighter (southwestern United States) *T. chamberlini*, new species.

KEY TO FEMALES

- 1 -Anterior tibiae with three pairs of spines beneath . . . 2
 Anterior tibiae with four pairs of spines beneath . . . 4
- 2 Epigynal plate longitudinally sulcate. . . 3
 Epigynal plate not longitudinally sulcate . *T. oblongus* (Walckenaer).
- 3 Median piece narrower or as narrow at genital furrow as between the openings *T. martinus* (Menge).
 Median piece much broader at genital furrow *T. punctulatus* (Taczanowski).
- 4 -Tibia with a conspicuous black maculation at base on dorsal surface *T. paraguensis* Simon.
 Tibia without such a marking . . . 5
- 5 -Median piece half as broad as the epigynal plate; openings set obliquely. *T. insularis*, new species.
 Median piece less than a third as broad as the epigynal area . . . 6.
- 6 Lateral margins of epigynal plate evenly rounded; median piece as long as the width at base . *T. chamberlini*, new species.
 Lateral margins of epigynal plate constricted anteriorly; median piece only half as long as basal width . . . *T. duttoni* (Hentz).

***Tibellus oblongus* (Walckenaer)**

Figures 1, 2, 3

- Arauca oblonga* WALCKENAER, 1802, *Faune Française*, II, p. 228
Thomisus oblongus WALCKENAER, 1805, 'Tabl. Aran,' p. 38, Pl. iv, fig. 39.
 PLAIN, 1831, 'Die Arachniden,' I, p. 40, Pl. xxviii, fig. 82.
Philodromus oblongus WALCKENAER, 1825, 'Ann. de France,' p. 94, Pl. vi, fig. 9; 1837, 'Ith. Apl.,' I, p. 558. BLACKWALL, 1861, 'Spiders Gr. Britain and Ireland,' p. 100, Pl. v, fig. 60
Philodromus trihaematus SUNDKVÄL, 1833, 'Svensk Spindl.,' p. 127.
Thanatus parallelus C. KOCH, 1838, 'Die Arachniden,' IV, p. 87, Pl. xxxii, fig. 307.
Thanatus oblongus MENGE, 1874, 'Preussische Spinnen,' Naturforschenden Gesellschaft, Danzig, pp. 306-308, Pl. lxvii, fig. 224 (not female)
Thomisus martinus MENGE, 1874, 'Preussische Spinnen,' idem, pp. 398-399, Pl. lxvii, fig. 225 (not male)
Tibellus propinquus SIMON, 1875, 'Les Arachnides de France,' II, pp. 309-310.
Tibellus oblongus KRYZHEVSKA, 1880, 'Die Spinnen Amerikas,' Laterigrada, p. 196. SIMON, 1895, 'Hist. Nat. Araignes,' I, p. 1065; 1903, Bull. Mus. Paris, LX,

p. 386. KULCZYNSKI, 1908, 'Aran. et Oribat.,' Mem. de l'Academie Imperiale, St. Petersbourg, VIII Serie, pp. 69-70

Tibellus parallelus KULCZYNSKI, 1901, 'Aranee Hungariae,' I, p. 115, Tab. iv, fig. 27

Tibellus duttoni EMBERTON, 1892, Trans. Conn. Acad. Sci., VIII, p. 378; 1902, 'Common Spiders,' p. 39, Figs. 114-116

MALE.—Total length, 6.65 mm

The integument of the cephalothorax varies from light yellow to brown or very dark brown in melanic specimens. Conspicuous on the carapace are three longitudinal brown bands: a median one that is anteriorly about as wide as the first row of eyes and which narrows to half of that width behind, and two lateral marginal bands beginning at a point laterad of the posterior lateral eye of each side and continuing posteriorly the remainder of the length of the carapace. The intervals between these stripes form two broader light yellow longitudinal bands with few invading brown markings. The eye tubercles are black. The sternum, labium, and endites are yellow, thickly speckled with brown, much darker than the legs and palps, which are yellow or light brown and are usually sparsely maculate or irrorate with brown flecks. Some males from southern Utah have the femora of all the legs, and the dorsum of the cephalothorax and the abdomen tinged a bright red.

The abdomen varies from gray to bright yellow, the dorsum with a median and two lateral brown bands as on the carapace, the median more plainly indicated, the venter entirely marked with brown or showing a median longitudinal broad dark band. Not uncommonly the color material arranges itself, as is characteristic of *Tetragnatha*, in blotches defined by lighter reticulations. At each side of the median band on the dorsum, approaching the end of the abdomen, is a small black spot. Spinnerets lighter than the venter.

Carapace, 2.70 mm. long, 2.10 mm. wide, .95 mm. in front.

Anteriorly the cephalothorax is armed with a few short spines in the region of the eyes and longer ones on the margin of the clypeus. The flat carapace is considerably longer than wide, truncate behind, the sides gently rounded anteriorly, to a constriction at the second eye-row, squared off in front, the width at that point being less than half the width of the carapace at the widest point. Both of the parts of the pronotum are on about the same plane, the thoracic furrow defining the pars cephalica poorly defined, the convex sides of the pars thoracica gently dropping to the margins. The clypeus is sloping and scarcely exceeds the height of the median ocular quad.

The eyes form two transverse recurved rows, those of the anterior with the medians two and one-half times their diameter apart and separated from the slightly larger laterals ($\frac{5}{4}$) by little more than their diameter, the posterior row much wider than the anterior, the curvature greater, the laterals equal to the anterior laterals. The posterior lateral eye of each side is somewhat farther removed from the anterior lateral than from the posterior median eye ($\frac{3}{2}$). The four median eyes form a quadrangle narrower in front ($\frac{13}{16}$) and broader than long as measured from above, the anterior medians equal to the posterior medians which are spaced nearly four times their diameter apart ($\frac{7}{16}$), nearer together ($\frac{1}{16}$) than to the posterior laterals.

Each chelicera is about twice as long as its width at base and distally narrowed, the upper margin armed with two teeth, the lower edentulate. The cordate sternum extends between the coxae of the last pair of legs and ends in a blunt point. The labium is as long as broad and about half as long as the convergent maxilla.

Abdomen, 4.05 mm. long, 1.3 mm. wide at genital furrow.

The abdomen is nearly four times as long as its greatest width and somewhat overlaps the posterior portion of the carapace.

The leg formula is 2413, the second being about five times the length of the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.20	1.30	2.80	2.00	1.25	10.55 mm.
II	3.80	1.20	3.40	2.95	1.85	13.10 mm.
III	2.65	1.00	2.07	1.77	1.01	8.50 mm.
IV	3.80	1.15	3.07	2.65	1.45	12.12 mm.

Although the spines are extremely variable in their length and are often missing from comparable members of the same spiders, the normal formula for all the legs seems to be the following.

	FEMUR	PATELLA	TIBIA	METATARSUS
Dorsal	1-1-1	0-0	0-0-1-0	0-0-0
Ventral	0-0-0	0-0	2-2-0-2	2-2-0
Prolateral	1-1-1	1-1	1-1-1-0	1-1-0
Retrolateral	1-1-1	1-0	1-1-1-0	1-1-0

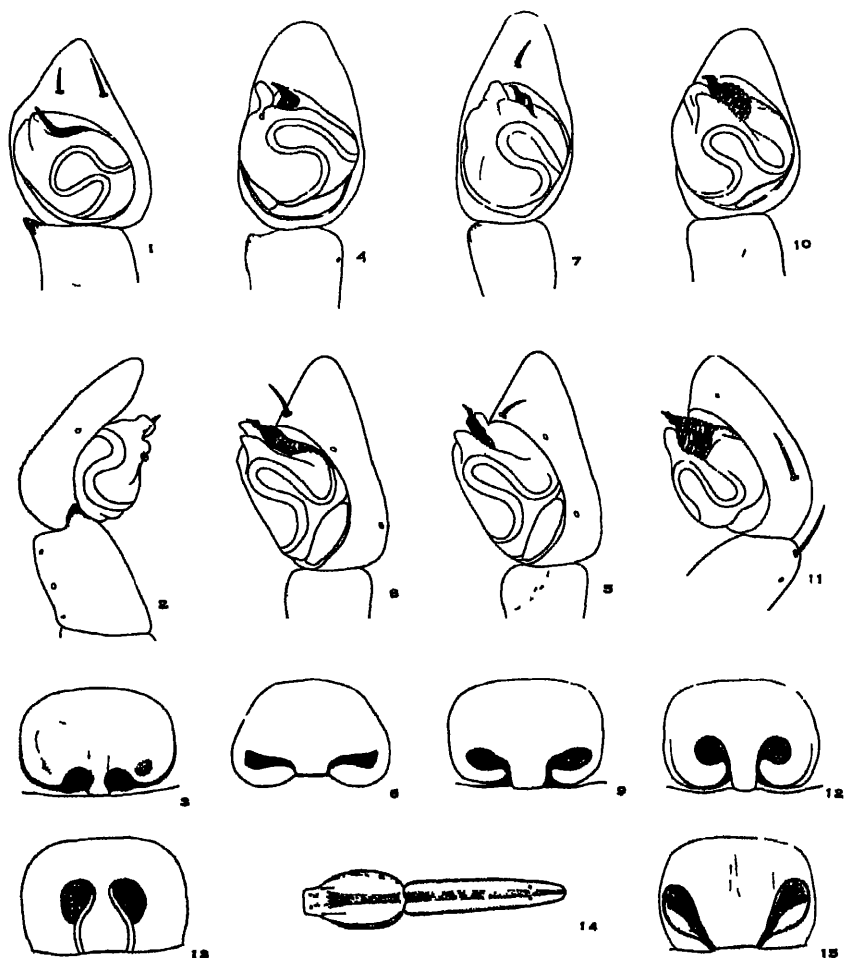
Tibia of male palpus: dorsal 2-1, ventral 0, prolateral 1-1, retrolateral 0. Tarsus: dorsal 2 basal, ventral 2 distal, prolateral 1 basal, retrolateral 0.

MALE PALPUS.—The femur is slightly longer than the patella and tibia which are equal in length as viewed from the lateral aspect. The tibia is slightly longer than broad and has on the outer margin a short but distinct tibial apophysis. On the inner (prolateral) surface of the tibial joint are two conspicuous, long black spines. The terminal joint of the palpus is longer than broad and clothed with black hairs and a few spines, the margin behind the embolus being set with a single line of slender bristles. The last joint of the palpus is bent downward and is so articulated to the tibia that it is twisted toward the outer side. The bulb is set obliquely with the straight black embolus pointing outward. Distally the embolus is twisted, resembling a screw. The course of the seminal duct on the bulb is somewhat variable.

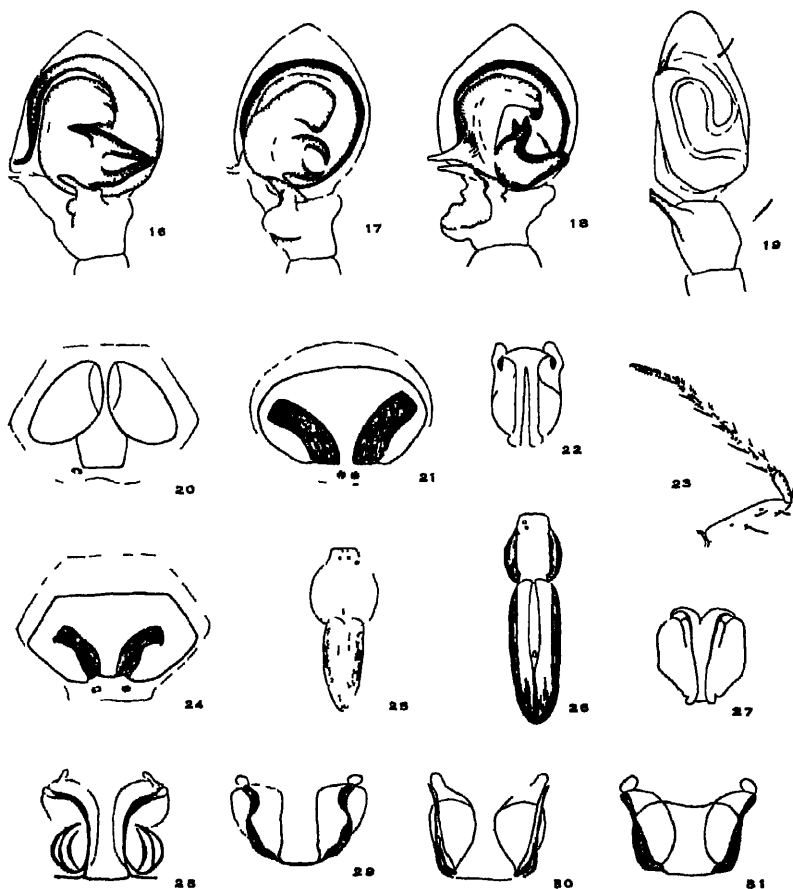
FEMALE.—Although in pattern the female closely approximates the male, the color is always much lighter. The characteristic bands of the carapace and the dorsum of the abdomen are well defined but the dark sternum and venter are usually lacking. On the average the male is a more slender spider, with the legs longer and with a more slender abdomen, which difference is greatly accentuated in females distended with eggs. The eye arrangement in the female is like that of the male, the anterior and posterior medians slightly farther separated.

Total length, 7.75 mm. Cephalothorax, 3.05 mm. long, 2.40 mm. wide, .95 mm. wide at the front. Abdomen, 5.00 mm. long, 1.75 mm. wide. The leg formula is 2413, the second leg about four times the length of the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.35	1.42	2.75	2.25	1.55	11.32 mm.
II	3.85	1.42	3.30	2.65	1.75	12.97 mm.
III	2.75	1.05	2.05	1.65	1.05	8.55 mm.
IV	3.85	1.25	2.90	2.45	1.45	11.90 mm.
Palp	.97	.52	.55		.95	2.99 mm.



- Fig. 1. *Tibellus oblongus* (Walckenaer), male palpus, ventral view.
 Fig. 2. *Tibellus oblongus* (Walckenaer), male palpus, retrolateral view.
 Fig. 3. *Tibellus oblongus* (Walckenaer), epigynum.
 Fig. 4. *Tibellus duttoni* (Hentz), male palpus, ventral view.
 Fig. 5. *Tibellus duttoni* (Hentz), male palpus, prolateral view.
 Fig. 6. *Tibellus duttoni* (Hentz), epigynum.
 Fig. 7. *Tibellus chamberlini*, new species, male palpus, ventral view.
 Fig. 8. *Tibellus chamberlini*, new species, prolateral view.
 Fig. 9. *Tibellus chamberlini*, new species, epigynum.
 Fig. 10. *Tibellus maritimus* (Menge), male palpus, ventral view.
 Fig. 11. *Tibellus maritimus* (Menge), male palpus, prolateral view.
 Fig. 12. *Tibellus maritimus* (Menge), epigynum.
 Fig. 13. *Tibellus punctulatus* (Taczanowski), epigynum (after Keyserling).
 Fig. 14. *Tibellus chamberlini*, new species, male, dorsal view.
 Fig. 15. *Tibellus insularis*, new species, epigynum.



- Fig. 16. *Xysticus patulus*, new species, male palpus, ventral view.
 Fig. 17. *Xysticus gosiulus*, new species, male palpus, ventral view.
 Fig. 18. *Xysticus coloradensis* Bryant, male palpus, ventral view.
 Fig. 19. *Apollophanes paraguensis*, new species, male palpus.
 Fig. 20. *Xysticus patulus*, new species, epigynum.
 Fig. 21. *Xysticus gosiulus*, new species, epigynum.
 Fig. 22. *Apollophanes bryanti*, new species, epigynum.
 Fig. 23. *Apollophanes paraguensis*, new species, first leg of female.
 Fig. 24. *Xysticus apachecus*, new species, epigynum.
 Fig. 25. *Apollophanes paraguensis*, new species, male, dorsal view.
 Fig. 26. *Apollophanes bryanti*, new species, female, dorsal view.
 Fig. 27. *Apollophanes paraguensis*, new species, epigynum.
 Fig. 28. *Apollophanes indistinctus*, new species, epigynum.
 Fig. 29. *Apollophanes arizonensis*, new species, epigynum.
 Fig. 30. *Apollophanes similis*, new species, epigynum.
 Fig. 31. *Apollophanes mexicanus*, new species, epigynum.

The spine formula for the female is like that of the male, but in some cases the dorsal basal spine on the anterior femora is lacking.

The specific name *oblongus* has been used by arachnologists for over a hundred years as a pigeonhole for any species of *Tibellus* coming into their collections. It is indeed fortunate that this is such a widely distributed spider and that a large proportion of the records probably belongs here. The involved synonymy is ample evidence of the confusion that has existed in regard to this species and to others related to it. Kulczynski in 1908 pointed out the discrepancies in nomenclature and hazarded that *Tibellus parallelus* (C. Koch) (in agreement with Simon) was worthy of specific designation. Most of the specimens from the United States have the embolus distally grooved in keeping with the diagnosis of this synonymized form, but I fail to see differences other than intraspecific in our specimens and retain the older name.

T. oblongus (Walckenaer) is found throughout Europe and Asia and distributed in North America from Alaska across to eastern Canada and south to Mexico, becoming scarcer in its southern limits.

Tibellus maritimus (Menge)

FIGURES 10, 11, 12

Thanatus maritimus MENGE, 1874, 'Preussische Spinnen,' Naturforschenden Gesellschaft, Danzig, pp. 398-399, Pl. LXVII, fig. 225 (not female).

Thanatus oblongus MENGE, 1874, 'Preussische Spinnen,' idem, pp. 390-398, Pl. LXVII, fig. 224 (not male).

Thomisus duttoni HENTZ, 1875, Occas. Papers Boston Soc. Nat. Hist., II, p. 81, Pl. XX, fig. 11 (plate by Emerton).¹

Tibellus oblongus SIMON, 1875, 'Les Arachnides de France,' II, pp. 311-312. CHYZER AND KULCZYNSKI, 1891, 'Araneæ Hungariae,' I, p. 115, Tab. IV, figs. 28a-b.

Tibellus maritimus KULCZYNSKI, 1908, 'Aran. et Oribat.,' Mem. de L'Academie Imperiale, St. Petersburg, VIII Serie, pp. 69-70.

MALE.—Total length, 6.15 mm. Cephalothorax, 2.80 mm. long, 2.05 mm. wide, .92 mm. wide in front. Abdomen, 3.35 mm. long, 1.30 mm. wide.

On the basis of coloration this species cannot be separated from the one described above, with which it has been confused in literature. The proportions of the carapace and the abdomen are decidedly similar, as are the eye relations, the spining of the legs and the armature of the upper furrow of the chelicerae. The legs average a little shorter, the second pair being only four times as long as the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.95	1.80	2.60	2.15	1.32	10.82 mm.
II	3.45	1.45	2.92	2.37	1.45	11.64 mm.
III	2.50	1.02	1.65	1.55	.85	7.57 mm.
IV	3.47	1.12	2.82	2.40	1.45	11.26 mm.

¹Supplementary notes in brackets by Emerton in the 'Spiders of the United States' (reprint) refer to this species.

The spine formula of the male agrees in all details with that of *Tibellus oblongus* (Walckenaer).

The female agrees in all structural details with that sex for *T. oblongus*. The epigynum as figured is longitudinally sulcate and readily distinguishable from that of any of the other species. The characteristic distal black spots on the dorsum of the abdomen are missing in every specimen that I have seen.

This is the spider Emerton figured as *Thomisus duttoni* Hentz in the 'Spiders of the United States.' In Trans. Conn. Acad. Sci., VIII, April, 1892, p. 378, he says: "I have not been able to find the spider whose palpus was figured by me on plate 20 of the reprint of Hentz's spiders of the United States in 1875. All that I have seen since have the slender portion of the tube longer. . . ."

This species was erroneously described as *T. oblongus* by Simon in his 'Arachnides de Franco,' 1875, and he was subsequently followed by European workers. Specimens from the Paris Museum kindly sent me by Miss Bryant under the above name agree perfectly with representatives from the United States. Kulczynski was the first to point out the error of Simon's determination and reinstated Menge's species, synonymizing *T. propinquus* Simon with the true *T. oblongus*.

Tibellus maritimus (Menge) has the same range as *Tibellus oblongus* but is of much less frequent occurrence. I have a male from Zion National Park, in southern Utah, which probably indicates the most southern distribution of the spider in the United States. Menge's specimens were from Germany, where he recorded it as being fairly common.

***Tibellus punctulatus* (Taczanowski)**

Figure 13

Thanatus punctulatus TACZANOWSKI, 1872, Horæ Soc. Entom. Ross., IX, p. 10.

Tibellus punctulatus KEYSERLING, 1880, 'Die Spinnen Amerikas,' Laterigradæ, p. 197, Pl. v, fig. 108. CHAMBERLIN, Bull. Mus. Comp. Zool., LX, No. 6, p. 264.

An immature female from Santa Ana, Peru (Mus. Comp. Zool., p. 253), referred to this species by Chamberlin, is a somewhat more slender spider than *T. oblongus* (Walckenaer), but agrees in having only three pairs of spines under the first and second tibiæ. At the basal end of the tibiæ of the dorsal surface on all the legs is a conspicuous black marking. The epigynum as figured by Keyserling is longitudinally sulcate, the median piece very broad and the openings large. The male agrees with *Tibellus vittatus* Thorell (*macellus* Simon) in possessing a distinct tibial apophysis.

This species is known only from Guiana and Peru.

Tibellus paraguensis Simon

Tibellus paraguensis SIMON, 1897, *Museu Torino*, XII, No. 270, p. 7.

I refer an immature female from S. Louis, Paraguay, to Simon's species, as it agrees in most particulars with his diagnosis. Beneath the tibiae of the first legs are four pairs of spines, the medians much nearer together than their distance from the distal or basal pairs. In other details this species is very close to *T. punctulatus* (Taczanowski) and has the same black maculation at the basal ends of the tibiae above on all the legs. "Plaga vulva rufula, coriacea, subrotunda, longitudinaliter sulcata."

This species has been found only at Asuncion (the type locality) and S. Louis, Paraguay.

Tibellus chamberlini, new species

Figures 7, 8, 9, 14

MALE.—Total length, 7.15 mm. Cephalothorax, 2.60 mm. long, 2.00 mm. wide, .80 mm. in front. Abdomen, 4.65 mm. long, 1.40 mm. wide

This species, a more slender spider than *T. oblongus* (Walckenaer), has the same color characteristics of other species of the genus. The median dorsal marking of the cephalothorax is continuous with a like one running the whole length of the slender abdomen. The lateral longitudinal marginal stripes of the carapace are well defined, those of the abdomen not visible from above but distinct from the lateral aspect. At the distal end of the cylindrical abdomen are the two black spots as in the other species and usually a second pair behind less distinct and often entirely missing.

The eyes form two strongly recurved rows, the first with the eyes subequal, separated by their diameter, the second row with the laterals a little larger, the medians separated twice their diameter and nearly twice as far from the laterals. The median ocular quadrangle is longer than broad, narrower in front ($\frac{1}{4}$).

The leg formula is 2413, the second being about five and one-half times the length of the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.40	1.30	2.95	2.50	1.52	11.67 mm.
II	3.95	1.45	3.60	3.10	1.90	14.80 mm.
III	2.55	.85	1.90	1.70	1.00	8.80 mm.
IV	4.30	1.15	3.40	2.95	1.50	13.80 mm.

The normal spine formula seems to be the following for both sexes.

	FEMUR	PATELLA	TIBIA	METATARSUS
Dorsal	1-1-1	1-0	0-0-1-0	0-0-0
Ventral	0-0-0	0-0	2-2-2-2	2-2-0
Prolateral	1-1-1	1-0	1-1-1-0	1-1-0
Retrolateral	1-1-1	1-0	1-1-1-0	1-1-0

The tibia of the male palpus is without an apophysis, slightly longer than the patella, which two joints taken together are as long as the tarsus. The bulb and the embolus are very much as in *T. duttoni* but the figure will show their differences.

FEMALE.—Total length, 9.60 mm. Carapace, 3.30 mm. long, 2.50 mm. wide, 1.20 mm. in front. Abdomen, 6.40 mm. long, 1.60 mm. wide

The leg formula is 2413, the second being not quite four and one-half times as long as the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.70	1.55	3.20	2.50	1.52	12.47 mm.
II	4.40	1.65	3.65	2.95	1.72	14.37 mm.
III	2.80	1.15	2.15	1.75	1.05	8.90 mm.
IV	4.50	1.40	3.35	2.85	1.45	13.55 mm.

The eyes of the median quadrangle are slightly farther apart, the distance between the anterior medians and laterals being proportionately less in the female.

TYPE LOCALITY.—Zion National Park, Utah, male holotype, female allotype, male and female paratypes, July 4, 1932 (Gertsch); male and female paratypes from the same locality taken in 1927 (A. M. Woodbury); male paratype, Elsinore, Utah, June 15, 1930 (Gertsch); female paratype, Monroe, Utah, July 6, 1930 (Gertsch); male paratypes, Laguna Beach, Calif., June 28, 1931 (Ivie); female paratypes, Notus, Idaho, June 11, 1931 (Ivie). Types in the collection of The American Museum of Natural History.

All records of *Tibellus duttoni* (Hentz) from the Great Basin region and west to the coast probably belong with this species. I have seen specimens from Colorado, Utah, southwestern Idaho, Arizona, and California. In Zion National Park in southern Utah it is the common species of the genus. It is a pleasure to name it for Dr. Chamberlin of the University of Utah.

Tibellus duttoni (Hentz)

Figures 4, 5, 6

Thomisus duttoni HENTZ, 1847, 'Spiders of U. S.' (reprint), Journ. Boston Soc. Nat. Hist., V, p. 448, Pl. XXIII, fig. 10; 1875, idem, p. 81, Pl. x, fig. 10.

Tibellus duttoni KEYSERLING, 1880, 'Die Spinnen Amerikas,' Laterigradae, p. 194, Pl. IV, fig. 107.

MALE.—Total length, 6.90 mm. Cephalothorax, 2.33 mm. long, 1.75 mm. wide, .71 mm. in front. Abdomen, 4.68 mm. long, .95 mm. wide.

This species closely approximates *T. chamberlini*, new species, in color but is much more slender and has very long legs. Two pairs of spots are usually found at the distal end of the abdomen in both sexes.

The leg formula is 2413, the second being about five times as long as the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.05	1.16	2.63	2.22	1.46	10.52 mm.
II	3.66	1.33	3.16	2.75	1.66	12.56 mm.
III	2.25	.75	1.66	1.37	.96	6.99 mm.
IV	3.75	1.12	3.00	2.50	1.37	11.74 mm.

The eyes are in two strongly recurved rows, the anterior median slightly smaller than the laterals, equally spaced about their diameter apart, the posterior row with the laterals larger, about half again as far from the median as they are from each other. The median quadrangle is not much longer than broad, narrower in front.

The spine formula in both sexes is like that of *T. chamberlini*, the anterior tibia with four pairs beneath.

FEMALE.—Total length, 9.67 mm. Carapace, 2.77 mm long, 1.85 mm wide, .95 mm. in front. Abdomen, 7.00 mm long, 1.55 mm wide.

The measurements are from a large female from Texas, much larger than the average representative of that sex from Georgia or Florida. The leg formula is 2413, the second pair over five times as long as the carapace.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.72	1.37	3.20	2.60	1.65	12.51 mm.
II	4.37	1.50	3.70	3.15	1.85	14.57 mm.
III	2.30	.85	1.60	1.37	.82	6.94 mm.
IV	4.35	1.85	3.30	2.70	1.40	13.60 mm.

The eyes of the median quadrangle are slightly farther apart, the comparative distance between the anterior medians and laterals being proportionately less in the female.

There seems but little doubt that this is the spider described by Hentz. His description and figure apply equally well to *Tibellus oblongus* as to this species, but as his original specimen came from Georgia, where this is the common species, I consider the name reliably established. Keyserling has given a good figure of the male palpus in his 'Die Spinnen Amerikas,' Laterigrade, 1880, when he regarded it as valid along with *T. oblongus* (Walckenaer), which he correctly identified. *Tibellus duttoni* (Hentz) is found in the southeastern part of the United States from Florida to Texas and down into Mexico, while in its northern range it has been taken in the Mississippi Valley to Minnesota and Michigan and on the east coast in New York and neighboring states. Specimens from Florida (Tampa, male and female, 1927, Uhler, collector) (Tallahassee, males, Aug. 1903, Morse, collector) agree in every important detail with those from other states in the southeast but are paler and average a little smaller.

Tibellus affinis Cambridge

Tibellus affinis CAMBRIDGE, 1898, 'Biol. Centr. Amer.,' Arach. Aran., I, p. 252, Pl. XXXI, fig. 11; 1900, *idem*, II, p. 133, Pl. IX, fig. 23.

As this species was described from an immature specimen, it cannot be identified without collections from the type locality, Amula, Guerrero, in southern Mexico. Structurally it is closely related to *Tibellus duttoni* and *chamberlini*, both of which undoubtedly extend down into Mexico, but I am convinced that it is not identical with either of those species.

***Tibellus insularis*, new species**

Figure 15

FEMALE.—Total length, 11.40 mm. Carapace, 2.80 mm. long, 1.30 mm. wide, .90 mm. in front. Abdomen, 8.80 mm. long, 1.60 mm. wide.

As in the other species the carapace is marked with the median and marginal longitudinal stripes characteristic of the genus. The abdomen has the lateral stripes only faintly indicated, the dorsal median one well marked. In the posterior third of the distal part of the abdomen are two conspicuous black spots.

The leg formula is 2413, the second pair being five times as long as the carapace.

	FEMUR	PATULLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.20	1.10	2.90	2.40	1.40	11.00 mm.
II	4.00	1.40	3.60	2.84	1.60	13.94 mm.
III	2.16	.56	1.48	1.20	.80	6.20 mm.
IV	4.20	1.00	3.20	2.60	1.30	12.30 mm.

The spination of the legs is like that of *Tibellus duttoni*, the anterior tibiae being armed beneath with four pairs.

The eyes are in two strongly recurved rows, equidistantly spaced, the anterior laterals only slightly larger, the posterior row with the laterals larger, the medians half again as far from the laterals as from each other. The median ocular quad is a little broader than long, narrower in front.

The only specimen known thus far is from south of Piñar del Rio, Cuba, Sept. 12-23, 1913 (female holotype) (F. E. Lutz) (collection of The American Museum of Natural History).

APOLLOPHANES O. P. Cambridge

CAMBRIDGE, 1898, 'Biol. Centr. Amer.,' Arach. Aran., I, p. 252.

In the second volume of the above cited reference Cambridge places the five names he had previously used for species of this genus under three, and suggests that his *Apollophanes maculatipes* may be the male of the species described as *A. punctipes*. Whatever the fate of these male specimens, I am inclined to believe *A. punctiger* Cambridge is distinct from this last species, where it has been synonymized. The species of this genus are very closely related and separable in the female sex by small differences in the eye relations, proportions of the carapace, and in the epigynum. Although I have been unable to connect any of the species described below with Cambridge's described forms, a study of his figures and descriptions seems to indicate that he was dealing with more species than he suspected.

***Apollophanes paraguensis*, new species**

Figures 19, 23, 25, 27

MALE.—Total length, 4.16 mm. Carapace, 1.88 mm. long, 1.66 mm. wide, .72 mm. in front. Abdomen, 2.28 mm. long, .82 mm. wide.

Integument of cephalothorax and appendages bright light yellow. Carapace yellow throughout, the lateral margins sparsely speckled with large flecks, indicating an indistinct broad lateral band on each side. Abdomen gray to yellow, medially with a light band, laterally with darker markings on the margins forming side bands and a dark spot on the median line at the middle of the abdomen. Legs light yellow, the dorsal and lateral surfaces of the basal joints sparsely marked with rather large maculations like those of the carapace, quite uniform in size, the distal joints immaculate. A larger conspicuous smudge or blotch at the base of all the tibiae on the lateral aspect.

Eyes in two strongly recurved rows, the anteriors about equal in size and equidistant, the posterior row much wider and about equally spaced, the medians smaller than the anteriors and the posterior laterals, which are slightly larger than those of the anterior row. Median ocular quad about as long as broad, narrow anteriorly, the medians a diameter apart, the posterior medians separated by over twice their diameter. Clypeus equal in height to twice the diameter of an anterior median eye.

FEMALE—Total length, 4.05 mm. Carapace, 1.76 mm. long, 1.50 mm. wide, .75 mm. in front. Abdomen, 2.28 mm. long, .88 mm. wide.

The female agrees in color and in structural details with the male. The spines beneath the tibiae in both sexes are 2-2-2, the distal pair smaller. The leg formula is 2143, the measurements below being for the female.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.07	.70	2.62	1.53	1.30	7.05 mm.
II	2.64	1.03	2.07	1.91	1.35	9.00 mm.
III	2.07	.06	1.76	1.50	.82	6.75 mm.
IV	2.41	.65	2.41	1.62	.90	7.99 mm.

Male holotype, female allotype, and male and immature paratypes from Asuncion, Paraguay (Reimoser Collection), deposited in the Museum of Comparative Zoölogy.

Apollophanes bryanti, new species

Figures 22, 26

FEMALE.—Total length, 5.41 mm. Carapace, 1.75 mm. long, 1.33 mm. wide, 1.07 mm. in front. Abdomen, 3.95 mm. long, 1.41 mm. wide.

Integument of the cephalothorax and appendages light brownish yellow. Carapace with two broad lateral brown stripes, the inner margins of which are straight, defining a median light band as broad as the posterior eye row. Clypeus with a few dark maculations. Legs heavily punctate with large round or oblong markings on the upper and lateral surfaces of the basal joints, the metatarsi and tarsi completely lacking them. Labium, sternum, coxae, and endites immaculate yellow. Abdomen with a light hastate marking from the base to the dark spot in the center of the dorsum, the lateral margins heavily maculate, forming two bands, the venter paler and with a few darker spots.

Eyes of the anterior row equidistant and about equal in size, larger than the posterior medians but smaller than the posterior laterals. Second row of eyes about equally spaced, the medians not much more than half as large as the laterals. Median ocular quad about as broad as long, narrow in front, the anterior medians separated by

more than a diameter, while the posterior medians are over three times their diameter apart.

Spines beneath the tibia 2-2 2, the distal pair much smaller. (A pair of spines nearly ventral in position intermediate between the middle and distal pair are considered to be lateral) Legs 2143.

Female holotype from Asuncion, Paraguay (Reimoser Collection) in the collection of the Museum of Comparative Zoölogy.

Apollophanes similis, new species

Figure 30

FEMALE.—Total length, 6 10 mm. Carapace, 2.33 mm. long, 2 08 mm. wide, .98 mm. in front. Abdomen, 3.91 mm. long, 1.66 mm. wide.

Integument yellowish, sparsely clothed with white hairs. Carapace with a median light band as broad as the posterior lateral eyes, the margins maculate with scattered brown flecks and markings, forming two broad side-bands. Sternum, labium, endites, and coxæ light yellowish, immaculate. Legs marked throughout with scattered flecks and spots. Abdomen clothed with white hairs, the dorsum with lateral black bands, a median longitudinal white band basally broader than that of the carapace and constricted posteriorly back of the black markings at the middle of the dorsum, the venter white with a few scattered black spots.

Both eye-rows strongly recurved, the anterior row with the medians smaller and nearer to the laterals than each other, the posterior row equidistantly spaced, the medians much smaller than the laterals. Median ocular quadrangle wider than long, the posterior medians slightly larger than the anteriors but not quite as large as the anterior laterals, the quad wider behind, the posterior medians more than three diameters apart, the anteriors separated by scarcely two diameters.

The anterior tibiae have 2-2-2 spines beneath, the distal pair small.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2 90	1 12	2 58	2 29	1 04	9.93 mm.
II	3.40	1.25	3.08	2.70	1 41	11 84 mm.
III	2.50	.91	1 87	1.87	75	7.90 mm.
IV	2.87	.91	2 08	2.08	1 00	8.94 mm.

Female holotype from Sabino Basin, Santa Catalina Mts., Arizona, taken July 8-12, 1916 (Lutz) (collection of The American Museum of Natural History).

Apollophanes arizonensis, new species

Figure 29

FEMALE.—Total length, 6.00 mm. Carapace, 2 16 mm. long, 2.00 mm. wide, .00 mm. in front. Abdomen, 3.91 mm. long, 2.00 mm. wide.

Integuments yellow throughout, with a sparse clothing of white hairs. Carapace practically glabrous, with a broad median light band, the sides somewhat darkened with streaks and markings indicating broad lateral bands. Sternum and basal parts of appendages unmarked yellow. Legs with a few scattered brown maculations. Abdomen with a very broad median longitudinal higher area that is somewhat in-

vaded by reddish-brown markings, the margins more heavily maculate, the characteristic median marking of the dorsum lacking.

Eyes in two strongly recurved rows, the anterior medians slightly farther apart and about equal in size to the laterals, the posterior row about equidistantly spaced, the medians much smaller. Median ocular quadrangle broader than long, the eyes subequal, the anteriors nearly two diameters apart, the posteriors separated by over three times their diameter. Clypeus about as high as the median ocular quad.

Spines under the first tibia 2-2-2, the distals smaller.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.71	1.21	2.33	2.24	1.08	9.57 mm.
II	3.29	1.37	3.04	2.65	1.21	11.56 mm.
III	2.50	1.00	1.95	1.76	.81	8.02 mm.
IV	2.40	.91	1.95	1.92	.91	8.00 mm.

Female holotype from Sabino Basin, Santa Catalina Mts., Arizona, taken July 8-12, 1916 (Lutz) (collection of The American Museum of Natural History).

***Apollophanes indistinctus*, new species**

Figure 28

FEMALE.—Total length, 6.00 mm. Carapace, 2.06 mm. long, 1.06 mm. wide, .90 mm. in front. Abdomen, 4.00 mm. long, 1.95 mm. wide.

Coloration as in *A. bryanti*, new species.

Eyes in two strongly recurved rows, the anterior medians smaller and nearer the laterals than to each other, the posterior eyes about equidistant, the laterals much larger. Median ocular quad broader than long, the posterior medians larger but not so large as the anterior laterals, the quadrangle narrower in front, the anterior medians separated by about two diameters while the posteriors are over three diameters apart. Clypeus about as high as the ocular quadrangle.

Spines under the anterior tibia 2-2-2.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.30	.95	2.08	1.83	.91	8.07 mm.
II	2.81	1.12	2.41	2.08	1.00	9.42 mm.
III	1.83	.71	1.46	1.54	.66	6.20 mm.
IV	2.50	.81	1.81	1.83	.83	7.78 mm.

Holotype and two female paratypes from La Buena Ventura, Vera Cruz, Mexico, July, 1909 (Petrunkévitch) (collection of The American Museum of Natural History).

***Apollophanes mexicanus*, new species**

Figure 31

FEMALE.—Total length, 7.33 mm. (holotype). Carapace, 2.75 mm. long, 2.50 mm. wide, 1.25 mm. in front. Abdomen, 4.65 mm. long, 2.35 mm. wide. Total length, 5.62 mm. (paratype). Carapace, 2.20 mm. long, 2.08 mm. wide, 1.00 mm. in front. Abdomen, 3.54 mm. long, 1.37 mm. wide.

Color as in *A. indistinctus*, new species.

Eyes in two strongly recurved rows, the anterior medians much smaller than the laterals and nearer them than to each other, the posterior row equidistant, the medians much smaller. Median ocular quadrangle broader than long, the posterior medians somewhat larger than the anteriors but smaller than the anterior laterals, the quad narrower in front, where the medians are nearly two diameters apart, than behind, where the medians are over three diameters apart. Clypeus about as high as the median ocular quad.

Spines under the first tibia 2-2-2.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.33	1.54	3.75	2.58	1.25	12.45 mm.
II	4.29	1.66	2.91	3.16	1.46	13.48 mm.
III	3.12	1.25	2.40	2.50	.81	10.08 mm.
IV	3.25	1.16	2.40	2.30	.91	10.02 mm.

Female holotype and female paratypes from La Zacualpa, Chiapas, Mexico, August, 1909 (Petrunkévitch) (collection of The American Museum of Natural History).

Xysticus C. Koch, 1835

Xysticus palutus, new species

Figures 16, 20

MALE.—Total length, 6.08 mm.

Carapace yellowish in color, with only a faint indication of a lighter median longitudinal band, the three well-defined dorsal streaks in the female missing or only faintly indicated, except near the posterior margin where they persist as black blotches. Sides of carapace orange to brown, the margins with a brown band. All eye tubercles white, except those of the posterior medians which are on brown patches. Abdomen with an indefinite pattern, mostly brown, with a few black and white transverse marks, the venter gray, black flecked.

Carapace, 2.72 mm. long, 2.68 mm. wide, 1.52 mm. in front.

Cephalothorax with black spines on the pars cephalica, six or seven long ones overhanging the chelicerae. Carapace as broad as long, highest between the second and third coxae, longer than the first femur, shorter than the patella and tibia of the first leg, longer than the femur and patella of the third leg, the width at the front more than half that of the widest point.

Eyes of the first row recurved, the medians about half as large as the laterals, nearer to the laterals than to each other. Posterior eyes recurved, equidistant, the laterals larger. Median ocular quadrangle as wide in front as behind, broader than long, the eyes about equal. Clypeus vertical, narrower than the height of the median ocular quadrangle, scarcely more than twice the diameter of an anterior median eye.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.66	1.28	1.92	1.92	1.04	8.82 mm.
II	2.66	1.28	1.92	1.92	1.04	8.82 mm.
III	1.76	.80	1.12	.88	.80	5.36 mm.
IV	1.76	.80	1.20	.96	.80	5.52 mm.

MALE PALPUS.—Femur about as long as the tibia and patella which are approximately equal in length. Tibia with two processes, the ventral outer one curved, distally truncated, a prominent tubercle at about the middle. The dorsal outer process about as long but not as heavy as the other, distally oblique. Cymbium somewhat longer than broad, distally bluntly pointed, the lateral margins rounded, the tutaculum quite prominent, a rounded spur that projects ventrad. Embolus rather heavy, the truncus black, about the same size throughout its length, the pars pendula widest basally, gradually becoming narrower until it fades out near the apical end of the truncus, no apical sclerite present. Median apophysis of the bulb a large long black spur which is attached near its middle, the ends free. Distal apophysis a somewhat shorter heavy black spur that is attached at one end, the apical portion of which projects beneath the other apophysis.

FEMALE.—Total length, 6.40 mm.

Carapace light yellow, with a light median longitudinal band as wide as the front eye-row, bounded on each side by a brown streak and with a median brown streak from the posterior median eyes to the cephalic suture, the cephalic portion of the band suffused with light brown and some white dashes, the thoracic portion unmarked white except for the customary black maculation at the median cephalic suture. Margins of pars thoracica with a narrow black stripe as wide as that bounding the margin of the median band, the intervals between these bands on the sides yellow with a few invading black marks. Legs concolorous with the carapace, marked with black, with three white marks the length of the legs above, the intervals between often darkened, forming bands. Abdomen darker yellow than the carapace, the dorsum with an indefinite pattern of black spots and tan streaks, the venter light immaculate yellow.

Carapace, 3.36 mm. long, 3.12 mm. wide, 1.92 mm. in front.

Cephalothorax as broad as long, highest between the second and third coxae, considerably longer than femur I or patella and tibia of the first leg, much longer than femur and patella of the third pair of legs, the width at the front decidedly more than one-half of the width at the widest point.

Eyes of the first row recurved, the medians about half as large as the laterals, nearer to the laterals than to each other, posterior row recurved, equidistantly spaced, the medians smaller than the laterals. Ocular quadrangle wider than long, the anterior larger, as far apart as the posteriors. Clypeus vertical, half as high as the median ocular quadrangle, about as high as two and one-half times the diameter of an anterior median eye.

EPIGYNUM.—Vulva broader than long, the anterior and lateral margins well rounded, the posterior truncated. Median longitudinal septum originating within the vulva anteriorly, broadly joined to the posterior margin, not half as wide as the width of the vulva (in some specimens narrower in front).

RANGE.—Male holotype, female allotype, and paratypes from St. George, Utah (Washington County); female paratypes from Thatcher, Arizona; female paratype from Salt Lake City, Utah (Little Cottonwood Canyon); male paratype from Notus, Idaho. (Types in the collection of the University of Utah; paratypes in The American Museum of Natural History.)

Only the examples from southwestern Utah in Washington County exhibit the conspicuous black streaks on the carapace. In many respects

this species approaches *Xysticus graminis* Emerton, a species of the eastern and New England States, but its greater size and slight differences in the palpus and epigynum will serve to separate it.

***Xysticus coloradensis* Bryant**

Figure 18

MALE—Total length, 5.60 mm

Carapace with a median longitudinal light band scarcely as wide as the anterior eye-row, the cephalic portion somewhat suffused with brown, the caudal part whitish, invaded by tan, the median cephalic maculation poorly defined. Median eyes on tubercles of a tan color, the laterals white. Sides of the carapace brown to black, with a few white and tan flecks. Chelicerae distally brownish, the remainder much invaded by brown. Sternum, coxae, and labium near black, flecked with white. Integuments of the legs yellow, the femora, patellae, and tibiae of the first two pairs heavily marked with black, the metatarsi and tarsi unmarked yellow, the last two pairs of legs lighter, blotched.

Abdomen white above, marked with a few black and tan spots, the venter whitish.

Carapace, 2.80 mm. long, 2.64 mm. wide, 1.20 mm. in front.

Cephalothorax set with spines as in typical *Xysticus*, six long black ones projecting over the chelicerae. Carapace slightly longer than wide, somewhat highest between the second and third coxae, the width at the front less than one-half the greatest width, shorter than the first femur, decidedly shorter than the tibia and patella of the first leg, shorter than the femur and patella of the third leg.

Eyes of the first row recurved, the medians nearer to the laterals than to each other, nearly half as large as the laterals. Posterior row recurved, the medians nearer to each other, smaller than the laterals. The tubercles of all the eyes conspicuous, those of the median quad high, conical, larger than in any species of the genus that I have yet seen. Median ocular quadrangle decidedly longer than broad, about as wide in front as behind, the eyes practically equal. Clypeus vertical, less than the height of the ocular quad, equal to about two and one-half times the diameter of an anterior median eye.

Legs all spinose, the first two tibiae armed beneath with five pairs of long spines, the last two tibiae with three pairs, the first two metatarsi with five pairs beneath. First two pairs of legs equal in length, the fourth slightly longer than the third (8.16-7.04).

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.04	1.20	2.32	2.56	1.20	10.32 mm.
II	3.04	1.20	2.32	2.56	1.20	10.32 mm.
III	2.24	.80	1.60	1.52	.88	7.04 mm.
IV	2.40	.80	1.92	1.92	1.12	8.16 mm.

MALE PALPUS.—Patella and tibia about the same length, the two equal to the femur. Tibia with two well-defined processes, the first an outer dorsal chitinated spur that is curved toward the bulb (dorsad), the second apophysis about as long, in lateral profile about half as broad as the former and situated on the outer dorsal surface; tibia also with a conspicuous large tubercle on the outer lateral aspect, the interval between it and the true apophysis excavated. Cymbium somewhat longer

than broad, bluntly pointed, the lateral margins quite straight, the tutaculum prominent, the inner cymbial portion a long chitinous spur that is directed laterad. Embolus heavy, the pars pendula easily seen for most of the length, without an apical sclerite. Bulb of palpus with a heavy bilobed process, the most outer spur deeply notched, the whole process apparently belonging to the distal bulbal portion.

RANGE.—Utah may be added to the list of states in which this species is found.

***Xysticus gosiutus*, new species**

Figures 17, 21

MALE.—Total length, 5.68 mm.

The median longitudinal light band of the carapace anteriorly is as wide as the first eye row, gradually narrowing caudad to about half that width, the cephalic portion orange with white streaks, the posterior lighter, a creamy white semilunar maculation at the cephalic suture. Eye region bright red, the tubercles light brown. Sides of the carapace a bright reddish-brown. The integument of the legs yellow to orange, the femora and patellæ of the first pair bright red, the tibia with basal and distal red annule, the metatarsi and tarsi yellow; the other three pairs of legs flecked with red and white. Tarsus of male palpus white above, brown blotched.

Abdomen above basally white with brown or black transverse bands and streaks, the venter with a large black spot between the spinnerets and the pedicel.

Carapace, 2.72 mm. long, 2.56 mm. wide, 1.36 mm. wide in front.

Clypeal margin with six long spines, the rest of the carapace sparsely set with shorter ones. Carapace a little longer than broad, shorter than femur I, scarcely longer than the tibia of the first leg, slightly shorter than the femur and patella of the third leg, highest between the second and third coxæ, the width at the front more than half the width at the widest point.

Eyes of the first row recurved, nearer to the larger laterals than to each other. Eyes of the second row recurved, the medians smaller and nearer to each other (3.0/4.0) than to the laterals. Median ocular quadrangle longer than wide, the posterior medians slightly larger, as far apart in front as behind. Clypeus vertical, about half as wide as the height of the ocular quadrangle, equal to about twice the diameter of an anterior median eye.

The first two pairs of legs equal in length, the last leg somewhat longer than the third, all legs spinose. The tibiae of the first two pairs with five pairs of spines beneath, the metatarsi of the first two pairs of legs with five pairs.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.28	1.12	2.56	2.48	1.28	10.72 mm.
II	3.28	1.12	2.56	2.48	1.28	10.72 mm.
III	2.00	.88	1.44	1.28	.88	6.48 mm.
IV	2.08	.88	1.68	1.44	.88	6.96 mm.

MALE PALPUS.—Femur of male palpus about as long as the patella and tibia which are nearly equal. Tibia with two processes, the lower outer one heavy, curved, the outer dorsal about as long, bluntly ended, not as heavy as the other. Cymbium longer than broad, laterally rounded, apically bluntly pointed. Tutaculum not prominent, the outer cymbial portion a blunt process. Embolus with the truncus

black, about the same width throughout its length, the pars pendula present through most of the length, the apical sclerite missing. Bulb of the palpus with a long, hook-like medial and a short distal apophysis

FEMALE.—Total length, 6.24 mm

Carapace with a median longitudinal band as wide as the first eye-row, the anterior portion light reddish-brown, the remainder white or nearly so, a creamy white semilunar streak at the median cephalic furrow, which lacks the customary dark maculation. Eye tubercles and region white. Sides of the carapace reddish yellow, with two darker bands at each side of the median longitudinal band. Abdomen sub-orbicular, pinkish, irrorate in brown.

Carapace slightly longer than broad, highest between the second and third coxae, decidedly longer than the first femur, longer than the tibia and patella of the first pair of legs, longer than the femur and patella of the third leg, the width at the front somewhat wider than half the greatest width.

Eyes of the first row recurved, the medians twice as far from each other as to the laterals which are over twice as large. Posterior row of eyes recurved, the medians smaller and nearer to each other than to the laterals. The median ocular quadrangle wider than long, the eyes near equal, the width in front only slightly wider than behind (6.0/5.5). Clypeus vertical, not as high as the height of the median ocular quadrangle, about two and one-half times the diameter of an anterior median eye.

	FEMUR	PATELLA	TIBIA	METATARBUS	TARBUS	TOTAL
I	2.40	.88	1.84	1.00	.88	7.00 mm.
II	2.40	.88	1.84	1.60	.88	7.00 mm.
III	1.02	.80	1.36	.88	.80	5.75 mm.
IV	2.00	.80	1.44	1.20	.80	6.24 mm.

FEMALE EPIGYNUM.—Vulva much broader than long, anteriorly flattened, laterally rounded, posteriorly somewhat flattened. Median septum very broad, widest in front, with the lateral extensions turned up (ventrad), forming two black chitinous ridges (closely resembling *X. locuples* Keyserling). The openings of the fertilization canals appear as two black spots much nearer the vulva than to the genital furrow. The atrio-bursal orifices are located at each side of the median septum and the heavy tubelike ridges somewhat fill that portion of the atrium.

RANGE.—Male holotype, female allotype, and paratypes of both sexes from Little Cottonwood Canyon, Salt Lake City, Utah, swept from the wild rose, July 17, 1929 (Gertsch); female and male paratypes from Zion National Park in southern Utah, July 4, 1931 (Gertsch). Types in the collection of the University of Utah; paratypes in The American Museum of Natural History.

This species is closely related to *Xysticus locuples* Keyserling which is found in the same locality, but it can be separated by differences in the eye relations, by the proportions of the apophyses on the bulb of the male palpus, and characters in the epigynum best shown by a figure. Keyserling's species is a heavier spider and lacks the normal long spines on the pars cephalica.

***Xysticus apachecus*, new species**

Figure 24

FEMALE.—Total length, 8.08 mm.

Integument of the cephalothorax white to yellow, the carapace with a broad median longitudinal white band and the width of the first row of eyes, immaculate, the customary black maculation at the cephalic suture absent. Eye tubercles and eye region white. The sides of the carapace light brown, two large black spots near the margins behind. Integument of the legs white, the first two pairs only marked faintly, the last two pairs, especially the femora, blotched in brown and with some creamy white maculations. Abdomen yellow, with a median white band on the dorsum, from which extend four transverse streaks on each side, below which are corresponding black streaks. Venter creamy white with brown markings.

Carapace, 3.28 mm long, 3.12 mm. wide, 1.84 mm. in front.

Cephalothorax lacking the conspicuous long spines of other species of the genus, the eyeregion practically smooth and with only short spines, the margin of the clypeus with the customary seven or eight long spines projecting over the chelicerae. Carapace slightly highest between the second and third coxae, anteriorly very gradually sloping to the eye region, posteriorly abruptly falling to the margin, slightly longer than broad, about as long as femur I, shorter than the tibia and patella of the first leg, longer than the femur and patella of the third leg, the width at the front more than half of the greatest width.

Eyes of the first row recurved, the medians less than half as large as the laterals, to which they are nearer than to each other. Eyes of the second row recurved, equidistant, the medians more than half as large as the laterals. Median ocular quadrangle only slightly narrower in front, wider than long, the medians (anterior) slightly smaller. Clypeus not quite as high as the height of the median ocular quadrangle, equal to about three times the width of an anterior median eye.

Legs with few spines, tibia I and II with six pairs and a single unpaired below, the metatarsi of these legs with five pairs beneath.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARUS	TOTAL
I	3.20	1.30	2.72	2.18	1.12	10.58 mm.
II	3.20	1.30	2.72	2.18	1.12	10.58 mm.
III	2.16	.80	1.60	.96	.88	6.40 mm.
IV	2.40	.80	1.66	1.20	.88	6.94 mm.

EPIGYNUM.—Vulva broader than long, the anterior margin straight, the lateral margins straight, diverging back at an obtuse angle, the posterior margin rounded. Median longitudinal septum broadly joined to the margins, caudally narrowed, the lateral septal margins revolved into a black chitinous tubular ridge on each side.

Female holotype from Blanding, Utah, April 17, 1928; female paratype from Texas (Cornell Collection) and from Grand Canyon, Arizona, north rim, July, 1931 (Gertsch). Types in the collection of the University of Utah; paratypes in The American Museum of Natural History.

This interesting species differs from all others of the genus in being devoid of the conspicuous long spines on the pars cephalica. It is closely related to *Xysticus locuples* Keyserling, *X. gosiutus*, new species, and to other undescribed forms that possess this type of epigynum.

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AN ANNOTATED CATALOGUE OF THE HYRACOIDEA IN THE AMERICAN MUSEUM OF NATURAL HISTORY, WITH A DESCRIPTION OF A NEW SPECIES FROM THE LOWER CONGO¹

BY ROBERT T. HATT

The preparation of an extended report on the Hyracoidea collected by the American Museum Congo Expedition has led to a review of the species of hyraxes represented in this museum. As certain observations made during this study would be somewhat irrelevant in a Congo report they are here given earlier publication, together with a description of a hitherto unrecognized rock hyrax collected by the Congo Expedition.

In the recognition of but a single genus of hyraxes I have followed Thomas, as species discovered since the time of his revision (1892, Proc. Zool. Soc., London., pp. 50-76) have only tended to strengthen his conclusion that every degree of gradation between characters of the genotypes of *Procavia*, *Heterohyrax*, and *Dendrohyrax* is to be found in some form.

It is a pleasure to thank the authorities of Field Museum of Natural History and the United States National Museum for the loan of specimens in their collections, and to acknowledge my appreciation for the helpful suggestions of Messrs. H. F. Anthony and James P. Chapin.

Procavia chapini, new species

TYPE.—American Museum of Natural History, No. 53800, American Museum Congo Expedition, No. 7002, adult (Stage VIII) female, skin and skeleton in good condition. Collected on the summit of Loadi Hill, five kilometers southwest of Matadi, Bas Congo District, December 27, 1914, by James P. Chapin.

GENERAL CHARACTERS.—A pale-colored rock hyrax with a well-marked light yellow dorsal spot. It approaches the typical members of the *Heterohyrax* group in its brachydont premolars and molars, the open orbits, the early closure of the parietal and interparietal sutures, the wide separation of the temporal fossae, and the double rooted PM₁. It differs from the typical heterohyraxes in its large size, long muzzle, flat dorsal profile, highly elevated basisphenoid, and in the mammary formula, which is 0-2=4.

DESCRIPTION.—Pelage coarse, the hairs short. The guard hairs of the back measure about 24 mm. in length. The general color of the back is near drab (color nomenclature of Ridgeway). The color over the head is darker than that of the back

¹Scientific results of the Congo Expedition. Mammalogy, No. 12.

and has a faint tawny wash overlying the area. Above the eyes is a broad band of light gray. The cheeks and sides are lighter than the back, but rather sharply demarcated from the belly, which is tawny yellow washed with light ochraceous over the chin and throat. Inside the ears is a small patch of light yellow hairs. The outer surfaces of the cheeks are covered with hairs the color of those in the interauricular region. Behind the ear is a lighter, grayer patch. The visible portion of the dorsal spot is about 50 mm. long and 10 mm. wide. Terminally its hairs are a pale olive-buff, basally they are white. The hairs of the fore and hind feet shade into a light gray.

The individual fur hairs of the anterior half of the back are a natal brown for their basal half. The shaft changes to a wood brown, then to another narrow band of natal brown. There is a pale olive-buff subterminal ring, 3 mm. broad, and a black tip. On the posterior part of the back the fur differs in that the basal half of the back is a light brownish-drab.

The skull is long and narrow, particularly in the nasal region. Its dorsal profile is very nearly straight from the middle of the parietals to the tip of the nasals. The occiput is moderately narrow. The temporal fossæ do not extend beyond the level of the anterior end of the supraoccipital and they remain widely separate from each other. The diastema is very long for a rock hyrax, about equalling the length of the premolar series. The cheek teeth are brachydont and narrow and the tooth-row very lightly bowed outward. The basisphenoid and basioccipital slope sharply down to their common suture which thus lies across a high eminence. The lacrymal bone extends forward along the maxillonasal suture for about 3 mm. Its process is as broad at its base as is the lacrymal bone. The lacrymal foramen is peripheral.

PARATYPE.—American Museum of Natural History, No. 53801, juvenile (Stage V) female, skin and skull. This specimen was collected the same day and in the same place as the type. In color it agrees closely with the adult specimen, and in cranial characters shows only a few age differences. The parietal and interparietal sutures are already closed.

MEASUREMENTS OF THE TYPE.—Collector's measurements of the animal in the flesh: total length, 430 mm.; tail, 10; hind foot, 60; ear from notch, 30. Skull measurements: greatest length, 95.0; condylobasal length, 94.6; length nasal suture, 22.0; frontal suture, 36.5; zygomatic breadth, 50.3; postorbital breadth, 25.7; greatest breadth nasals, 21.0; least distance between lacrymal and malar, 4.7; height premaxilla, 11.8; length premaxilla, 22.0; closest approximation of temporal fossæ, 12.2; temporal fossæ to occiput, 8.5; skull height, 31.9; breadth palate inside M^1 , 16.8; diastema, 16.2; width PM^2 , 3.8; width M^1 , 5.3; height M^2 , 2.5; length PM_1 , 3.4; length upper PM - M series, 32.0; length mandible, 84.7.

Procavia chapini is not closely related to the neighboring Angolan hyraxes. From the coastal species, *Procavia welwitschii*, it differs in all the respects that separate it from other members of the *capensis* group. The inland Angolan species, *P. bocagei*, differs greatly from *chapini* in color and character of the fur, which in the Angolan species is long and luxuriant. In cranial characters there is greater resemblance, both species bearing the stamp of the *Heterohyrax* group. The chief differences lie in the smaller size, broader teeth, proportionately broader

skull, elevated supraorbital ridges, shorter snout, and flatter basicranium of *boragei*.

Procavia chapini combines pelage, cranial, and mastological characters in a manner hitherto unreported for any other species, and for this reason it is given full specific rank.

HYRAXES IN THE AMERICAN MUSEUM COLLECTIONS

Procavia capensis (Pallas)

Cavia capensis PALLAS, 1767, Spicel. Zool., fasc. II, p. 16

Four skins, four skeletons, four skulls, and one in alcohol, from various sources; localities unknown.

It is possible that some of these represent *P. habessinicus*, from which, it appears, *P. capensis* cannot be differentiated in juvenile skull stages.

Procavia capensis capensis (Pallas)

Cape Colony, George District, Zebra: one skin and skull; T. S. Heyns, collector.

Cape of Good Hope: one mounted skeleton, on exhibition.

Procavia capensis natalensis Roberts

Procavia capensis natalensis ROBERTS, 1924, Ann. Transvaal Museum, X, part 2, p. 76.

Natal, Pondoland: one skin with skull.

Natal: three skins with skeletons; B. N. Bridgman, collector.

The specimen from Pondoland, a half-grown individual, is peculiar for the broad band of dark hair crossing the throat, and for the reduced size and sharp definition of the white areas of the under parts.

The four skulls, all young, show remarkably large parietals for members of the *capensis* group. The parietal of one Stage V skull was 15.5 mm. broad and 11.2 long.

Procavia capensis coombi Roberts

Procavia capensis coombi ROBERTS, 1924, Ann. Transvaal Museum, X, part 2, p. 76.

Southern Rhodesia, Matabeleland, Gwanda: one skin with skull; R. Douglas, collector.

Transvaal, Pretoria district: one skin with skull; A. Haagner, collector.

***Procavia welwitschii* (Gray)**

Hyrax welwitschii GRAY, 1868, Ann. Mag. Nat. Hist., (4) I, p. 43.

Angola, Hanha: one skin with skull; II. Lang, collector.

Angola, Mossamedes: two skins with skulls; II. Lang, collector.

Angola, Pico Azevedo: one skin with skull; II. Lang, collector.

All of these skins have a conspicuous light spot over the eye and numerous well-defined black spots distributed over the back and flanks. These black patches lie immediately behind the long vibrissæ-like hairs that are scattered over this region.

***Procavia butleri* Wroughton**

Procavia butleri WROUGHTON, 1911, Ann. Mag. Nat. Hist., (8) VIII, p. 461.

Sudan, Jebelain: five skins, two skeletons, three skulls, two in alcohol; H. E. Anthony, collector.

***Procavia scioana* (Giglioli)**

Hyrax scioanus GIGLIOLI, 1888, Ann. Mus. Genova, VI, p. 21.

A skin with skeleton of a hyrax once living in the New York Zoölogical Park may be referred to this species. The exceptionally great extent of the black dorsal spot, enormous body size and great diameter of the teeth are in marked contrast to hyraxes of the *capensis* group.

***Procavia syriaca* (Schreber)**

Hyrax syriacus SCHREBER, 1784, 'Säugethiere,' Pl. cxxi-B; 1792, idem, VI, p. 923.

Syria: one skull and two juvenile skeletons without skulls.

***Procavia alpini* (Gray)**

Hyrax alpini GRAY, 1868, Ann. Mag. Nat. Hist., (4) I, p. 45.

Abyssinia, Walamo, Lake Abaya: one skin with skull; T. D. Carter, collector.

***Procavia alpini minor* Thomas**

Procavia abyssinica minor THOMAS, 1892, Proc. Zool. Soc., London, p. 66.

Sudan, Red Sea Hills, Khor Sabat: one skin with skull; H. E. Anthony, collector.

This specimen, a female with the third molar worn down almost to the cingulum, was measured by the collector as follows: total length, 475 mm.; tail, after skinning, 28; foot, 65.

The cranial measurements are: greatest length, 79.5; condylobasal length, 77.3; zygomatic breadth, 14.5; length nasal suture, 18.3; length upper diastema, 7.5; length premolar-molar series, 33.3, breadth M^1 , 6.7.

***Procavia mackinderi mackinderi* Thomas**

Procavia mackinderi THOMAS, 1900, Proc. Zool. Soc., London, p. 176

Kenya Colony, Mt. Kenya, alt. 14,500 ft.: two skulls and other skull fragments; J. P. Chapin, collector.

One of these pick-up skulls is that of an extremely old individual in which a necrotic condition of the left half of the mandible was associated with loss of the lower incisors and consequent overgrowth of the upper incisors. The smoothly worn tips of these, at the points where they would have encountered the skin, attest that the animal remained alive long after the normal feeding process had become impossible.

Another dental anomaly encountered in one of the fragments is an extremely deep groove in the median surface of the right upper incisor. The back of the alveolus of this tusk is exposed and shows that this groove at the growing root is occupied by a thin sheet of bone. The left upper incisor, also in place, has no counterpart of this groove.

***Procavia mackinderi zelotes* Osgood**

Procavia mackinderi zelotes OSGOOD, 1910, Field Mus. Nat. Hist., Zool. Ser., X, No. 2, p. 5.

Kenya Colony, Kijabe: two skins with skulls and incomplete skeletons; H. Lang, collector.

Kenya Colony, Kidlong Valley, Quarantine Station: three skins with skulls; J. P. Chapin, collector.

The series examined, including the type and three paratypes of *zelotes*, and other specimens from the Field and National Museums, has shown that *Procavia mackinderi zelotes* and *Procavia jacksoni* are not representatives of different species, but that they grade one into the other to such an extent that many specimens from the Rift Valley in the region of Naivasha cannot strictly be assigned to one form more than to the other.

Respective of the intergradation of *jacksoni* and *zelotes* it may be noted that in essential cranial characters there is the following assortment:

Closed orbits are found only in the type of *zelotes* (from between Naivasha and Kijabe) and in specimens from Kijabe.

Temporal fossæ extended to occipital plane are found in adult specimens from Kijabe, in the type of *zelotes*, and in specimens from the Kidong Valley and Naivasha. They are not so elongated in specimens from Elmenteita.

The short, broad type of skull with short diastema is encountered at Kijabe, in the type of *zelotes*, and in specimens from the Kidong Valley and Loita Plains. Elongated skulls with long diastema are found at Naivasha and Elmenteita.

Flattened frontals with raised supraorbital ridges are characteristic of the type of *zelotes* and specimens from Kijabe, the Kidong Valley and Loita Plains. An arched frontal is found in specimens from Elmenteita and Naivasha.

The temporal fossæ of the type of *zelotes* and specimens from Kijabe, the Kidong Valley, Loita Plains and Lake Naivasha approach to form a small sagittal crest, whereas these fossæ in specimens from Elmenteita remain widely separate.

The molariform teeth of *zelotes* type, and specimens from Kijabe, the Kidong Valley and Loita Plains are broader than those in specimens from Naivasha and Elmenteita.

In characters of the pelage there appears to be no constancy, for while specimens from the Kijabe-Kidong region average somewhat redder than those from the region of Elmenteita, individual specimens in each group resemble individuals in the other so perfectly that no distinction is possible.

Hyraxes of this group from Mt. Lololokwi and the Rumathe River, referred by Hollister (1924, Bull. 99, U. S. N. M., p. 140) to *zelotes*, are different from their neighbors to the south and west in a consistently lighter gray color and slightly greater skull size, but not different enough, perhaps, to justify nomenclatorial distinction.

A peculiarity exhibited in a young specimen (Stage VI) from Lake Naivasha (U. S. N. M. No. 162826) is the obliteration of the interparietal-supraoccipital suture. Because in other characters it agrees with other representatives of the *mackinderi* group, it doubtless is but a variant of this species.

The specimens from Kijabe were mentioned by J. A. Allen in his report on the mammals of the Tjäder Expedition (Bull. A. M. N. H., XXVI, Art. 12, p. 166). Here the older of the specimens was assigned to *Procavia jacksoni*, the other to *Procavia brucei*.

***Procavia mackinderi jacksoni* Thomas**

Procavia jacksoni THOMAS, 1900, Proc. Zool. Soc., London, p. 176.

Kenya Colony, Elmenteita: three skins with skulls; H. Lang, collector.

Kenya Colony, Solai: one skin with skull; H. Lang, collector.

The specimens from Elmenteita are those referred by J. A. Allen (*loc. cit.*) to *Procavia brucei*, and that from Solai (between Ravine and Lake Hannington), doubtfully assigned to the then little-known *P. emina*. Although this Solai hyrax is too young (Stage V) to make identification certain, the general agreement in skull characters and the proximity to the type locality of *jacksoni* lead me to consider it a color mutant of that race.

An East African skin without skull, collected by Paul J. Rainey, but otherwise without data, is tentatively referred to this form

***Procavia matschiei* Neumann**

Procavia matschiei NEUMANN, 1900, Zool. Jahrb., Syst., XIII, p. 555.

Tanganyika Territory, Mwanza, Sagayo: nine skins and twelve skulls; A. Loveridge, collector.

Tanganyika Territory, Mwanza, Shandwa: six skins with skulls; A. Loveridge, collector.

Eighteen of the twenty specimens mentioned in the Loveridge report (Proc. Zool. Soc., 1923, p. 739) under the name of "*Procavia brucei matschiei*" were the above listed specimens, whereas the two others were *Procavia brucei victoria-njansae*. It is not surprising that Mr. Loveridge did not recognize the presence of two distinct species of hyrax in his collections made in the Mwanza district, for superficially they bear striking resemblance. Though the skulls of these two species are totally different in size and characters, one being typical of the small-toothed *Heterohyrax* group, the other of the large-toothed *Procavia*, their skins are easily confounded. However, they may be distinguished by their dorsal spots. In *P. matschiei* this spot is broad, and there is a naked area of skin in its center. In *P. brucei victoria-njansae*, on the other hand, the hairs of the dorsal spot cover a narrow, linear area in which there is no bare spot.

***Procavia lopei* Thomas**

Procavia lopei THOMAS, 1907, Ann. Mag. Nat. Hist., (7) XIX, p. 520.

Belgian Congo, Upper Uele, Aba: twenty skins with skulls, five skeletons, one fetus in alcohol; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Upper Uele, Faradje: one skin with skull; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Upper Uele, Vankerekhovenville: one skin with skull; J. P. Chapin, collector.

A full report of this series will appear in a forthcoming bulletin.

***Procavia erlangeri comata* Brauer**

Procavia erlangeri comata BRAUER, 1917, Sitz. Ber. Gesell. Naturf. Freunde, p. 302.

Abyssinia, ten miles south of Harrar: one skin with skeleton; T. D. Carter, collector.

Abyssinia, Harrar: two native skins; T. D. Carter, collector.

Abyssinia, Harrar, Dokgou: one skin with skull, one fetus in alcohol; B. Brown, collector

Mr. Carter tells me that the black-headed hyrax which he shot south of Harrar was in the same rock pile with the specimens of *Procavia brucei hararensis* that he collected the same day.

***Procavia brucei hararensis* (Brauer)**

Heterohyrax brucei hararensis BRAUER, 1917, Sitz. Ber. Gesell. naturf. Freunde, p. 297.

Abyssinia, ten miles south of Harrar: seven skins with skulls; T. D. Carter, collector.

Abyssinia, Harrar: one skeleton; B. Brown, collector.

The specimens collected by Mr. Carter are possibly from the same rocks as the type and paratypes of Brauer, since, as he states, the specimens were taken in the rocky area nearest Harrar. Brauer's description applies well to the specimens, except for diastema length which is given as 14.7 to 16.3 mm. and which in the series at hand does not exceed 9.5.

***Procavia brucei borana* Lonnberg**

Procavia brucei borana LONNBERG, 1912, Ann. Mag. Nat. Hist., (8) IX, p. 66.

Kenya Colony, Archer's Post: two skins with skulls; Eastman-Pomeroy-Akeley Expedition.

***Procavia brucei maculata* Osgood**

Procavia brucei maculata OSGOOD, 1910, Field Mus. Nat. Hist., Zool. Ser., X, No. 2, p. 6.

Kenya Colony, Lukenya Hills: nine skins with skulls, three alcoholics¹; Eastman-Pomeroy-Akeley Expedition.

¹In the collections of the Department of Comparative Anatomy, A. M. N. H.

Kenya Colony, Sultan Hamud: two skulls; J. L. Clark, collector.

The series of topotypes collected by the Eastman-Pomeroy-Akeley Expedition is interesting in the bearing that it has on the contested status of Osgood's race. These specimens were collected in May and June, the type, and presumably the paratypes, in December. In two things the American Museum specimens are not accurately characterized by the type description. Osgood states that the dorsal spot is almost entirely pure white, whereas in the series that I have examined there is a strong cinnamon element in the dorsal spots of most specimens. Further, though the describer noted a strong black spotting of the back in his specimens, no trace of such spotting is seen in the present series except one very old male with greatly worn teeth.

***Procapra brucei victoria-njansae* (Brauer)**

Heterohyrax brucei victoria-njansae BRAUER, 1917, Sitz. Ber. Gesell. naturf. Freunde, p. 299.

Tanganyika Territory, Mwanza, Sagayo: two skins with skulls; A. Loveridge, collector.

Tanganyika Territory, Mwanza, Shandwa: one skin with skull; A. Loveridge, collector.

As noted in this list, under the heading of *Procapra matschiei*, the collector confused the two rock hyraxes of the Mwanza district and reported them under the composite name "*Procapra brucei matschiei*."

From its nearest relative to the south, *P. b. prittwitzi*, this race differs strikingly in the following external characters:

1.—In *victoria-njansae* the dorsum of the hind feet is dark and grizzled; in the southern race the area is silvery white.

2.—In *victoria-njansae* the belly is yellowish white; in the contrasted form it is white.

3.—The crown is rufous in *P. b. victoria-njansae*, whereas in *prittwitzi* it is usually a darker shade of the back color.

4.—There is no conspicuous superciliary spot in *victoria-njansae*, whereas in the southern race there is a large, avellaneous superciliary spot.

***Procapra brucei prittwitzi* (Brauer)**

Heterohyrax brucei prittwitzi BRAUER, 1917, Sitz. Ber. Gesell. naturf. Freunde, p. 299.

Tanganyika Territory, near Itigi, Gwaos: one skin with skull; A. Loveridge, collector.

Tanganyika Territory, Dodoma, Mahaka: three skins, two skulls; A. Loveridge, collector.

Tanganyika Territory, Mkalama, Mtali's: one skin with skull; A. Loveridge, collector.

Tanganyika Territory, Lake Rukwa: one skull; Capt. Terpich, collector.

Tanganyika Territory, Singida, Mjengo's: six skins, five skulls; A. Loveridge, collector.

Tanganyika Territory, Singida, Poona: one skin with skull; A. Loveridge, collector.

Tanganyika Territory, Tabora: one skin; A. Loveridge, collector.

Tanganyika Territory, Tindi (between Mwanza and Tabora): two skins with skulls; F. G. Carnochan, collector.

Tanganyika Territory, locality not known: two skins; A. Loveridge, collector.

The specimen from Lake Rukwa, though a topotype of *Heterohyrax munzneri rukwaensis* Brauer, appears to be referable to the smaller form, represented so well by the Loveridge collection.

It is interesting to note that in both *Procavia b. prittwitzi* and *P. b. victoria-njansæ* the parietal suture closes later in life than it does in other members of the *Heterohyrax brucei* group (*albipes*, *borana*, *hararensis*, *maculata*) remaining open over the anterior third of its course in some specimens of Stage VIII.

Procavia lademanni (Brauer)

Heterohyrax lademanni BRAUER, 1917, Sitz. Ber. Gesell. naturf. Freunde, p. 298.

Tanganyika Territory, Maripindi's (a village about one day's march north of Mt. Rungwe): two skins with skulls; R. Boulton, collector.

The two specimens are in Stage III. The mammary formula of 1—2=6, the fused parietals and interparietal, the supraoccipital pattern, are characteristic of a "*Heterohyrax*." The orbits, though yet open, are so nearly closed that one may presume closure in the adult. The fur character resembles that of the dendrohyraxes more than it does the typical hyraxes.

Procavia chapini Hatt

Described on p. 1 of this paper.

Belgian Congo, vicinity of Matadi: two skins with skeletons, two embryos in alcohol; J. P. Chapin, collector.

***Procavia bocagei* (Gray)**

Hyrax bocagei GRAY, 1800, Ann. Mag. Nat. Hist., (4) III, p. 242.

Angola, Benguela, Chitau: one native skin; H. Lang, collector.

Angola, Benguela, Luimbale: one skin with skull; C. P. Chapman, collector.

Angola, Iluila, Lubango: one skull and two embryos in alcohol; H. Lang, collector.

The mammary formula in a very young individual is 0—2=4 or possibly 1—2=6.

***Procavia adolfi-friederici* Brauer**

Procavia (Dendrohyrax) adolfi-friederici BRAUER, 1913, Sitz. Ber. Gesell. naturf. Freunde, p. 182.

Belgian Congo, Central Kivu volcanoes, Kabara, 11,000 ft.: one skin with skull; J. P. Chapin, collector.

Belgian Congo, Kivu District, near Kibati, 6500 ft.: one skin with skull; J. P. Chapin, collector.

Belgian Congo, N. slope of Mt. Karisimbi, 11,100 ft.: one skin with skull; J. P. Chapin, collector.

The Kabara specimen (Kabara is a site on the saddle between Mt. Mikenno and Mt. Karisimbi) is virtually a topotype of *Procavia (Heterohyrax) helgei* Lonnberg and Gyldenstolpe, and agrees with the description of this species in every particular. However, three specimens in the Field Museum, collected by Edmund Heller at Kisolo (western Uganda, between Rutshuru and Kabale) would appear to bridge the gap between *helgei* and *adolphi-friederici*, with which the describers of the first do not seem to have made comparison, the subgeneric assignation of Brauer's species being somewhat misleading. The mammary formula of this species is 1—2=6.

***Procavia adametzi zenkeri* Brauer**

Procavia adametzi zenkeri BRAUER, 1914, Sitz. Ber. Gesell. naturf. Freunde, p. 88.

French Congo, Karagoua Koudou: one skin; A. Baudon, collector.

Cameroon, Edea: one skull; Gerloff, collector.

***Procavia emini* (Thomas)**

Dendrohyrax emini THOMAS, 1887, Ann. Mag. Nat. Hist., (5) XX, p. 440.

Belgian Congo, southern Uele, Akenge: three skins with skulls; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Ituri, Avakubi: one skin with skull; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Ituri, Gamangui: four skins with skulls and one skeleton; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Ituri, Medje: five skins with skulls, three skeletons, a gravid uterus and some viscera in alcohol; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Ituri, Ngayu: one skin with skeleton; H. Lang and J. P. Chapin, collectors.

Belgian Congo, Uele, Niangara: three skins with skulls and one skeleton; H. Lang and J. P. Chapin, collectors.

Belgian Congo, southern Uele, Niapu: twenty-one skins with skulls and one skeleton, 3 fetuses in alcohol; H. Lang and J. P. Chapin, collectors.

A study of this fine series will be published in the report on the Hyracoidea collected by the American Museum Congo Expedition.

***Procavia emini latrator* Thomas**

Procavia emini latrator THOMAS, 1910, Ann. Mag. Nat. Hist., (8) V, p. 285.

Belgian Congo, middle Congo River, Bolobo: one native skin; H. Lang, collector.

Belgian Congo, middle Congo River, Lukolela: one native skin; J. P. Chapin, collector.

***Procavia ruwenzorii* Neumann**

Procavia ruwenzorii NEUMANN, 1902, Proc. Zool. Soc. London, 1902, II, p. 143.

Belgian Congo, West Ruwenzori, Bugongo Ridge, 8950 ft.: one mandible; J. P. Chapin, collector.

Uganda, East Ruwenzori: five skulls and fourteen mandibles; Carveth Wells, collector.

***Procavia terrieola schusteri* (Brauer)**

Dendrohyrax? erricola schusteri BRAUER, 1917, Sitz. Ber. Gesell. naturf. Freunde, p. 298.

Tanganyika Territory, Uluguru Mts.: five skins and skulls; A. Loveridge, collector.

***Procavia crawshayi* Thomas**

Procavia (Dendrohyrax) crawshayi THOMAS, 1900, Proc. Zool. Soc. London, p. 178.

Kenya Colony, Mt. Kenya: one skin with skull and partial skeleton; H. Lang, collector.

Kenya Colony, Nyeri: one skin with skull; F. G. Carnochan, collector.

Kenya Colony, Kijabe: one skin with skull; H. Lang, collector.

Kenya Colony, Kikuyu Escarpment, above Kijabe Station: four skins without skulls; A. J. Klein, collector.

Kenya Colony, locality unknown: one skeleton and sixteen skulls; A. J. Klein, collector.

The Nyeri specimen is somewhat lighter in color than that from Mt. Kenya, and the skins collected by Mr. Klein are darker and with a richer fur than either of these, but in other characters of the pelage there is close harmony. The series of skulls collected by Mr. Klein, for which all original data unfortunately has been lost, show a wide variation in sutural details of the occipital and parietal regions, but these seem to be fortuitous and in all probability every skull may be referred to *crawshayi*.

***Procavia crawshayi laikipia* (Dollman)**

Dendrohyrax crawshayi laikipia DOLLMAN, 1911, Ann. Mag. Nat. Hist., (8) VIII, p. 131.

Kenya Colony, Uasin Gishu Plateau, 6000 ft.: four skins with skulls; Jenness Richardson, Jr., collector.

Kenya Colony, Nzoia Plateau, Cheringani Hills, 8700 ft.: one skin with skull; Jenness Richardson, Jr., collector.

These hyraxes, though differing in a few respects from the type description of *P. c. laikipia*, appear to be referable to that race. The skins bear a striking superficial resemblance to *P. bettoni*, but in the skull and in the character of the dorsal spot are very close to *crawshayi*. Unlike *crawshayi* the orbits of these specimens are not completely closed. These are the hyraxes that were referred to *Dendrohyrax bettoni* by Dr. J. A. Allen (Bull. A. M. N. II., XXXIII, Art. 26, p. 340) in his report on the Rainsford-Richardson Expedition.

***Procavia bettoni* Thomas and Schwann**

Procavia bettoni THOMAS AND SCHWANN, 1904, Abstr. Proc. Zool. Soc., London No. 6, p. 23. (See also Proc. Zool. Soc., London, 1904, I, p. 463.)

Kenya Colony, Muthaiga (near Nairobi): two skins with skulls; D. L. Sage and F. P. Matthews, collectors.

There is a single pair of inguinal mammae in this species.

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ROCKY MOUNTAIN BEES.—IV

By T. D. A. COCKERELL

All the bees recorded below were collected by Dr. F. E. Lutz, except when the contrary is specified.

Anthophora infernalis (Dalla Torre)

Utah: Eureka, May 26, June 8 and June 14, 1920 (Tom Spaulding). They agree with a specimen from Claremont, California (Baker), and this adds one more to the growing list of bees ranging from California as far east as Utah. The species was originally described from Nevada. It is extremely similar to the European *A. acervorum* (Linnaeus).

Anthophora montana Cresson

Colorado: Elbert, June 9–11, 1922, at approximately 7400 ft., male.

Melitoma grisella Cockerell and Porter

Colorado: Regnier, one female. The subfamily formerly called *Entechninae* must be called *Melitominae*.

Ancylosceles sejuncta, new species

Male.—Length about 7.5 mm., anterior wing 5 mm.; black, with the tarsi more or less rufous, the hind basitarsi clear chestnut-red, with a long sharp basal tooth; clypeus very prominent, it and labrum entirely black; mandibles dusky rufous, without any light spot; eyes gray; flagellum faintly reddish beneath; hair of head and thorax white; mesothorax shining but closely punctured; metathorax dull at base, but beyond that polished; tegulae dark rufous; wings perfectly clear, stigma ferruginous; abdomen long and narrow, shining, excessively minutely punctured, bases of tergites 3 to 6 rufous (this doubtless mostly concealed when abdomen is contracted), tergites with white, apical hair-bands.

Colorado: Regnier, Baca County, June 6–7, 1919. The hind femora are enormously swollen, as is usual in the genus. Nearest to *A. melanostoma* Cockerell, from La Paz, Lower California, but easily separated by the largely red mandibles and clear red stigma. This genus, characteristic of Central and South America, is new to the United States, and its discovery in Colorado is very surprising. For an account of the genus and its curious history, see *Entomological News*, XXXII, p. 76.

Tetralonia lutziana, new species

MALE.—Length about 12.5 mm., anterior wing 8.6; black, with the clypeus (squarely notched laterally) and labrum light lemon-yellow; mandibles rufous on outer side of apical half; flagellum reaching middle of second tergite, dark reddish beneath; scape stout; third antennal joint not three times length of second, and on its longest side less than one-third length of fourth; eyes swollen, dark brown; face narrow, the facial quadrangle much longer than broad; mesothorax dull in front, but the posterior disc highly polished, with few punctures; hair of head creamy white, very long and abundant on cheeks; thorax above, and first two tergites, with rich though rather pale yellowish-fulvous hair; on under side of thorax the hair is paler, but not white; wings hyaline, slightly grayish; nervures dark brown; second cubital cell much over half the length of first; recurrent nervures received about equally distant from ends of second and third cubital cells; hind wing with twelve hooks; legs ordinary, with light yellow hair, small joints of tarsi light red; mid-tarsi with basal joint (basitarsus) parallel-sided, not narrowed apically, or twisted; hind basitarsi thick, much broader than second joint, reddened at apex, and furnished with long hairs; hair on inner side of hind basitarsi very bright ferruginous; abdomen shining, the first two tergites closely and finely punctured; tergites 2 to 6 with very distinct, entire bands of pale grayish hair; apical plate parallel-sided, very broadly truncate; sides of apical tergite with short dense yellow hair; last sternite with a shining transverse sulcus.

Colorado: Boulder, May 25, 1922, at approximately 5500 ft. Most nearly related to *T. lepida* (Cresson), but distinguished by the proportions of the antennal joints and cubital cells, the reddened under side of flagellum, and the absence of any small yellow spot at base of mandibles. It is also distinguished by the quite normal middle tarsi. From *T. snoviana* (Cockerell) it is known by the thickened hind basitarsi and other characters. There is a rather strong superficial resemblance to the Chinese *T. jacoti* Cockerell, the abdominal bands having quite the same appearance, though *jacoti* has only three.

Tetralonia dilecta (Cresson)

Colorado: Elbert, June 9–11, 1922, female.

Tetralonia cordleyi orophila Cockerell

Colorado: Boulder, June 7, 1922, 6500–7100 ft., female. Topotype (Frank B. Lutz).

Tetralonia vagabunda (Cockerell)

Colorado: Boulder, May 18, 1913, at flowers of *Mertensia linearis*, male (M. M. Ellis).

***Tetralonia acerba* (Cresson)**

Colorado: Boulder, May 24, 1913, at flowers of *Erysimum wheeleri*, male (M. D. Ellis).

Utah: Eureka, May 20 and June 7, 1920 (Tom Spalding).

***Tetralonia atriventris* (Smith)**

Utah: Eureka, May 30, 1920 (Tom Spalding), female. This female agrees with one from Illinois, collected by Robertson. I have a strong feeling that the two *T. acerba* males ought to go with it, but they are certainly not the male *T. atriventris* of the Eastern States. The matter is commended to collectors in Utah; but as things now stand, the two species are separated as follows.

FEMALES

Abdomen with a white hair-band on fourth tergite, and a white spot on each side of third. *acerba* (Cresson).

Abdomen without white hair beyond the first tergite; a further distinction is the clear red (instead of black or dark fuscous) hair on inner side of hind basitarsi. *atriventris* (Smith).

MALES

Yellow of clypeus not at all notched at sides; abdomen beneath with black hair, except near base. *atriventris* (Smith).

Yellow of clypeus strongly notched at sides; abdomen beneath with much white hair. *acerba* (Cresson).

***Tetralonia speciosa* (Cresson)**

Colorado: White Rocks, near Boulder, June 5, 1922, male. This is the true *T. speciosa*, with fulvous hair on hind tibiae; the variation *gilletti* (Cockerell) has this hair white.

***Emphoropsis morrisoni* (Cresson)**

Colorado: Boulder, May 25, 1922 at *Pentstemon*, male.

***Nomia* (*Dieunomia*) *apacha* Cresson**

Colorado: Crowley, Sept. 1, 1932 (M. T. James), female.

***Nomia* (*Epinomia*) *triangulifera* Vachal**

Colorado: Crowley, Sept. 1, 1932 (M. T. James), male.

***Nomia bakeri* Cockerell**

Colorado: Crowley, Sept. 1, 1932 (M. T. James). Three females; one is var. *rufibasis* Cockerell.

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NEW ASILIDÆ FROM COLORADO

BY MAURICE T. JAMES

Descriptions of three new asilids from Colorado are given in this paper. The types have been deposited in The American Museum of Natural History.

HODOPHYLAX, new genus

A single specimen, which was collected along a cow-trail through a dry pasture in southeastern Colorado, seems so unique among the Nearctic *Dasypogoninae* that I am proposing a new genus for its reception. It may readily be separated from all other members of the subfamily by the absence of pulvilli, the simple claws, robust form, and reduced mystax. The vertex, front, and face are moderately wide, their sides being almost parallel, only slightly convergent opposite the base of the antennæ. The vertex is moderately hollowed out; the ocellar triangle tuberculate. The front is thrice grooved, these grooves converging toward the bases of the antennæ; one groove arises on either side and one near the apex of the ocellar triangle. The head is about one and one-half times as broad as high. The body is short and stout; the thorax considerably humped; the abdomen short, pendant, about one-half as broad as long; the venter is considerably cupped-in; the ovipositor ends in a circle of spines. The legs are short and stout; the tibia and tarsi are quite bristly, as in *Ablautus* Loew. The wings are hyaline, the five posterior cells open, and the anal cell is closed at the margin. The wing venation resembles that of *Ablautus*, to which this genus seems most nearly related.

GENOTYPE.—*Hodophylax aridus*, new species.

The following table of characters will distinguish *Hodophylax* from *Ablautus*.

<i>Hodophylax</i>	<i>Ablautus</i>
1.—Mystax confined to oral margin; face bare, except for moderately long sparse pile	1.—Mystax dense and extending to the base of the antennæ
2.—The two basal segments of the antennæ with only sparse bristles	2.—The two basal segments of the antennæ densely covered with bristles
3.—Bristles lacking on the anterior part of the thorax	3.—Anterior part of the thorax clothed with conspicuous hairs and bristles
4.—Anal cell closed and short-petiolate	4.—Anal cell closed in the wing margin

Hodophylax aridus, new species

FEMALE. Face, front, and vertex black, densely clothed with white pollen which all but conceals the ground color. Ocellar triangle with a tuft of diverging white bristles. Antennae moderately long, cylindrical, the first two segments subequal, reddish, each bearing a terminal white bristle ventrally, that of the second by far the longer, being several times the length of the segment; third segment black, long, cylindrical, about one and one-half times the combined lengths of the first and second segments, and terminating in a short, thick style which in turn terminates in a microscopic bristle. Thorax black, but the ground color is almost completely concealed by brown and gray pollen, the brown pollen forming two dorsal stripes which merge behind the suture into a large brown region. Humeri large, prominent, covered with brown pollen. Pleura, except sternopleura and pteropleura, densely gray pollinose, the sternopleura and pteropleura bare. Trichostical hairs long and slender, white. Scutellum with two pairs of white bristles laterally. Abdomen shining black; segments two to six inclusive are white pollinose for the most part, but the pollen lacking in spots as follows. an anterior margin and broad dorsal band on the second segment; paired semicircular spots on the third, fourth, fifth, and sixth segments, these spots being joined by anterior margins on the third, fourth, and sixth segments; round mid-dorsal spots on the third, fourth, and sixth segments, vaguely outlined on the fourth and broadly connected with the lateral semicircles and anterior margin of the sixth, so that the entire dorsum of this segment is shiny. Pile white. Venter gray pollinose. Coxae shining black, white pollinose and pilose on the outer surfaces; femora shining red, except apically, bare except apically and on the outer surfaces of the hind femora; tibiae and most of tarsi black. Pile and bristles of legs white, some black bristles on the tarsi. Claws very long, slender, black. Length, 7 mm.

HOLOTYPE.—Female, Crowley, Colo., Sept. 1, 1932 (M. T. James).

Deromyia coloradensis, new species

Similar to *D. angustipennis* Loew, to which it is most closely related. It differs as follows: the veins of the wing are distinctly clouded, particularly toward the apex and in the anal region; in the discal cell, the clouding is heaviest in the region surrounding the veins; in the anal region, the veins are bordered with subhyaline. The wing venation is variable in both species; but in *D. coloradensis* the veins closing the discal and the fourth posterior cells meet at a decided angle, and the petiole of the fourth posterior cell, as a rule, is shorter than in *D. angustipennis*. The vitta of the thorax are darker; the paler pollinose markings of the abdomen are more obscure and form bands, rather than lateral triangles. The bristles of the thoracic pleura and of the pronotum are darker as a rule, and with an occasional brown bristle. The palpi and the entire proboscis are black; in *D. angustipennis* the palpi and the base of the proboscis are red.

Types.—Holotype, male, Gregory Canon, Boulder, Colo., Aug. 10, 1932. Allotype, female, Gregory Canon, Boulder, Colo., Aug. 2, 1932. Paratypes, three males, Gregory Canon, Boulder, Colo., Aug. 2, 10, 1932. All types collected by the author.

Proctacanthus rodecki, new species

Length, 36 to 42 mm. Entirely reddish brown to black, densely covered with grayish pollen, through which the ground color plainly shows on the face, legs, and

apical segments of the abdomen in the female, but which completely covers the ground color of the thorax and of the basal abdominal segments. Palpi and proboscis black; palpi clothed with long, hairlike bristles which, like the remaining vestiture of the head, are pale, almost white. First and second antennal segments red; third black; style one and one-third times the length of the third antennal segment, black, its apex white. Thorax with short, erect, bristle-like pile, which is wholly black; a few pale hairs at the posterior angles; ordinary bristles of thorax and scutellum, together with the smaller bristles in the precutellar region of the thorax, white; a few of the larger bristles of the thorax black. Pile and bristles of the pleura, coxæ, and first five abdominal segments, and the pile of the femora, white; bristles of the femora, tibiae, and tarsi black; pile of the tibiae and tarsi white, with some black pile anteriorly on the middle and hind tibiae and all tarsi. Anterior femora red; posterior femora reddish black; the middle ones intermediate in color. Terminal segments of abdomen and genitalia gray pilose in the male, with short, erect, black pile, in the female except just before the ovipositor, genitalia of male red; of female, black, with a quite distinct, strong circle of spines.

Types. —Holotype, female, Roggen, Colo., July 17, 1930 (H. G. Rodeck). Allotype, male, Roggen, Colo., July 17, 1930 (H. G. Rodeck). Paratypes, female and two males, Roggen, Colo., July 17 and 25, 1930 (H. G. Rodeck).

This species may be separated from all other Nearctic forms except *P. duryi* Hine by the white vestiture of the scutellum and palpi. It is a much larger fly than *P. duryi* and differs from it in the color of the pile of the thorax and the color of the femora. The length of the vein at the base of the second posterior cell and the narrowing of the first posterior cell are characteristic. In these respects it differs from *P. milberti* Macquart, which it closely approaches in appearance.

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SOME DACEINE AND CERATITINE TRYPETIDÆ (DIPTERA) FROM AFRICA IN THE COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

By H. K. MUNRO

Through the kindness of Mr. C. H. Curran, I have been able to examine a number of unnamed Trypetidæ in The American Museum of Natural History. Although the species are few, they are of much interest and serve to show that there are still numerous species of Trypetidæ to be discovered in the African region, not to mention the many species described from only one sex or on otherwise inadequate material. The types of the new species are in The American Museum of Natural History.

Daculus (*Chaetodaculus*) *æthiopicus*, new species

This is one of the more important discoveries among the African Dacine. The anterior supra-alar and prescutellar bristles are well-developed and may be placed in *Chaetodaculus*, a subgenus hitherto recorded only from the oriental and australasian regions. It seems to come close to a group which includes *D. (C.) ferrugineus tryoni* Froggatt, *i.*, and *xanthodes* Broun.¹ The nearest ally may be the last, which also has a single hypopleural spot, but apparently a different pattern.² Both have the scutellum reddish centrally and yellow on the sides, but the African species is definitely black, and has no humeral spots, as noted by Malloch³ in *D. xanthodes*.

Among possible relationships among the oriental species, two seem allied: namely, *Daculus* (*Daculus*) *oleæ* Gmelin and *Daculus* (*biguttulus*) Bezzi. The three differ progressively in their anterior bristles: in *D. æthiopicus* both anterior supra-alar and prescutellar are present, in *D. biguttulus* only the latter, and in *D. oleæ* both are absent. Both of the two latter species differ from the first in their third abdominal segment in the male ciliate. However, apart from these points noted, the three species agree in a character that is of more importance than the differences in chaetotaxy:

¹ *Is. of Fiji Islands*, pp. 100-102.
² *Ann. N.S.W. Farmers' Bull.* 24, Pl. IV, fig. 3.
³ *Insects of Samoa*, pt. 6, Dipt., fasc. 7, p. 260.

namely, that the abdominal segments are not fused, as in the case of most of the African *Dacinae*, but are free. The question of the status of the subgenera of *Dacus* in general, and it is hoped to discuss this in a forthcoming paper.

MALE, FEMALE.—Length of body: male, 5.5 mm., female, 7.9 mm.; wing, male, 5.0 mm., female, 6.8 mm. The three males available are all markedly smaller than the females, but two rather teneral-looking females are as small as the males. Head, proportions of length, height, and width in types: male, 7, 9, and 11; female, 8, 11, and 13. Occiput not prominent below, shining blackish ferruginous, orbits yellow, narrow above, wider below. Frons parallel-sided, a little narrower than an eye, twice as long as wide in male, slightly wider in female, flat with a slight broad tubercle anteriorly, bare, brownish (sometimes yellowish) ferruginous across vertex, ocellar dot large, shining blackish, subintegumentary orbital spots absent in males, usually somewhat developed, sometimes strongly developed in females, as is central area on tubercle; bristles black, two strong inferior and a single superior orbital; a pair of minute hairs may represent the ocellars. Lamellae ferruginous, of moderate size. Antennae rather long, about twice as long as face, first two joints subequal, third three times as long as first, brown, third joint with black tip and more or less black, especially on outer side. Face yellow, with two large rounded shining black spots, cheeks narrow, yellow, genae wider with large subocular brown spot; palpi brown to blackish, proboscis short. Thorax shining black, pubescence black, but anterior edge of pronotum bare, the rather thin gray dust on dorsum is interrupted by shining median and dorsocentral stripes, and laterally behind suture fairly wide, yellow, arcuate vittae. Humeri, a moderate mesopleural stripe from top of sternites to notopleura, and a single hypopleural spot, yellow; bristles black, outer cerviculae, two notopleurals, an anterior and two posterior supra-alars, prepectellar, one mesopleural present, no humerals. Scutellum somewhat swollen and convex above, yellow, with a broad median ferruginous stripe (a little narrower than apex); postscutellum and mesophragma black with gray dust. Halteres yellow. Legs: coxae slightly ferruginous, femora yellow, front pair with a more or less extensive brown spot on outer surface near distal end; front tibiae moderately ferruginous, middle rather less on distal half, hind strongly ferruginous; metatarsi paler or yellow, rest of tarsi darkened. Wing: venation normal, almost hyaline with brownish veins, stigma light brown, marginal cell pale yellow, in submarginal along costa a barely perceptible infuscation that develops into a rather poorly defined spot on tip of third vein; anal stripe not well developed, anal cell and re-entrant angle of anal cross-vein brownish. Abdomen large, oval, segments not fused, pubescence brownish (on lighter parts) to black. Abdomen black on sides, with a moderate (one-third of width), median brownish stripe on which is a narrow median black stripe; both stripes widen somewhat backward, the black on the sides of the fifth segment therefore being much less. In the female the sixth segment is short and concealed beneath the fifth. Venter blackish; base of ovipositor shining ferruginous, of a peculiar shape, much like the last joint of one's finger in general appearance and proportions: that is, more or less cylindrical, somewhat wider than deep, and broadly rounded at apex. The lateral sutures are fairly pronounced and in most of the specimens the base of the ovipositor has become more or less flattened in drying. Almost no pubescence above, sparse below, but rather long and hairlike below apex. Length of base, 1.2 mm.

Laokolé, left bank Congo River, 1° 5' S., Dec. 16, 1930, J. P. Chapin.
 Laokolé, Nov. 21, 1930. Two male and twelve female paratypes,
 31, 1931, same data.

Dacus (*Leptoxyda*) *longistylus* Wiedemann

Specimens from Dabolak, British Somaliland, Dec. 12, 1920, P.4980b, and from Hargesia, British Somaliland, Dec. 5-7, 1920, P.4979.

Dacus bivittatus Bigot

There is little doubt that *Dacus pectoralis* Walker, 1863, is the same as *D. bivittatus* Bigot, although it may be regarded as a variety. The difference between them seems to be only that in *bivittatus* the broad costal margin reaches to the middle of the first posterior cell while in *pectoralis* it is extended to the fourth vein. This extension is always strong in South African specimens, but in central African material it seems to tend to be faint or absent. At the present time I have not sufficient material to study the forms more closely.

In the present material are two specimens from Laokolé, left bank Congo River, 1° 5' S., Jan. 1, 1931, J. P. Chapin, and one from Banga, Liberia, Oct., 1920, in which the extension is faint. A specimen from Mouda, Liberia, Oct. 31, 1920, is teneral.

Dacus eburneus Bezzi

One specimen, Laokolé, left bank Congo River, 1° 5' S., Sept., 1930, J. P. Chapin. There is little doubt that this is *D. eburneus* Bezzi. The wing pattern is identical with Terzi's drawing¹ except that the brown extends a little over the fourth vein into the second posterior cell. The thoracic markings are yellow rather than ivory-white, the front part of humeri being ferruginous; three yellow postsutural vittæ are present; the abdomen is paler only at extreme tip.

Further, it would seem that *D. eburneus* and *D. momordica* Bezzi are the same, in which case *momordica* must stand as the name of the species. The description of *momordica* (as *bipartitus* Graham, by Silvestri²) is not very clear, but the hyaline streak above the last portion of the fourth vein is doubtless abnormal; such streaks often occur on the fuscous wing-markings of *Dacina*, especially in roared specimens. The presence of the median postsutural vitta and its absence in *eburneus* does not seem of much importance. Also the apparent sinuosity of the

¹Bezzi, 1915, Bull. Ent. Res., VI, p. 94, Fig. 8.

²Diagn. of Ent., Hawaii, Bull. III, p. 90, Pl. xxiv, fig. 2. (Note: *D. bipartitus* Graham is a synonym of *D. bivittatus* Bigot. Author.)

end of the fourth vein is often misleading; Silvestri's figure does not represent it as any more bisinuous than does that by Terzi.

***Dacus gypsoides*, new species**

A fair-sized, elongate, black species, with a moderately border on the wing and pale legs. It is somewhat difficult to find real affinities of this species as it seems to belong to a group from any previously recorded. Owing to the absence of supra-alar bristles it would have to be included in *Dacus* and might perhaps be placed in the neighborhood of *Coquillett*. It would certainly not come near the *D. vert*. On the whole, it seems much more likely that its affinities to be closer to *D. cburneus* Bezzi, etc., in spite of the a bristles noted.

MALE.—Length of body, 8.2 mm, of wing, 7.4 mm. Head a little fifth higher, and three-fourths wider, than long. Occiput black; yellow orbital stripe moderate but rather undefined, widening behind; testaceous; top third, a bar across middle, and spots at lower interior brown; very short, sparse, brownish pubescence; bristles black, verticals strong, two medium inferior orbitals, superior orbitals above alveoli, but vertical plates are distinct, ocellars small, hair-like, and somewhat backward. Lunule blackish ferruginous, about three long. Antennae twice as long as short part of face, russet, third joint ened and first less strongly, third joint about twice as long as second three times third; arista brown, bare, base yellow. Face almost three-quarters, broadly yellow across epistome, cheeks and genae yellow. Eyes relatively large in profile, palpi yellow, thickened and by apex, proboscis short, dark yellow. Thorax: on dorsum dull black except anteriorly and on median and dorsocentral stripes; on propleura, a narrow margin around and including inner anterior corner along notopleura, reddish; hind portions of pleura blackish; periphragma dull black with slight narrow median ferruginous stripe; mesosternites long, whitish, shorter on coxae. Humeri (except inner) a moderate mesopleural stripe from top of sternites to dorsocentral hypopleural spot, yellow; bristles black, inner and outer very notopleurals, one mesopleural; anterior supra-alar absent. Scut narrow ferruginous; two rather long apical bristles; apex con length. Halteres yellow. Legs golden yellow, coxae somewhat ferr third of tibiae very slightly so. Wing: venation normal; a broad yellow in costal cells, brown from stigma, filling base of first basal marginal and submarginal cells and, opposite the end of the second extend halfway across first posterior cell and ending below wing-tip, anal cell, and narrowly along its outer side ending faintly toward cloud below end of sixth vein well developed but not strongly d

of sixth vein, 5 to 2; thoracic squamæ elongate, yellow. Abdomen twice as long as wide, more or less parallel-sided, black; a wide, rather narrow second segment, slightly interrupted in middle, third segment almost yellow on hind margin and oval areas brownish; pubescence mainly on thorax; venter and genitalia blackish ferruginous, middle very long pubescence, short and inconspicuous on last.

le, Lukolela, left bank Congo River, 1° 5' S., Jan. 13, 1931, J. P.

***Dacus vertebratus* Bezzi**

rather pale specimens, Dabolak, British Somaliland, Dec. 1980b.

***Dacus ficiola* Bezzi**

Iargesia, British Somaliland, Dec. 5-7, 1920. F. 4979.

***Dacus annulatus* Becker**

Banga, Liberia, October, 1928. It agrees with published figure¹ shows the ends of the femora much paler than the case.

***Dacus maynéi* Bezzi**

Lukolela, left bank Congo River, 1° 5' S., Jan. 13, 1931, . This specimen agrees with Bezzi's description.² The rather deeply bifid, but this without doubt is anomalous.

***Dacus abbassæ*, new species**

black species with yellow face very like *D. binotatus* Loew, distinct anal and a strong costal stripe on the wing.

MEAS.—Length of body: male, 5.0 mm., female, 5.3 mm.; of wing, female, 4.5 mm. Head: proportions of length, height, and width, 6.5, 10, 10. Blackish ferruginous, yellowish behind vertex, and orbits moderate yellow. Frons parallel-sided, about as wide as an eye and two-thirds of length, darker centrally and behind, orbital spots indistinct, ocellar plates shining blackish ferruginous, latter with longer pubescence here inconspicuous; bristles black, inner and outer verticals strong, and two inferior orbitals short, about a quarter to a third width of frons, airlike, paler, about as long as orbitals. Lunule blackened testaceous; 1st as face, first and second joints blackened ferruginous, third elongate, 4th of second, black in male, paler in female, testaceous on inner side face yellow, only slightly convex, cheeks a shade darker, a brownish

oy. Ent. d'Égypte, II, Pl. II, fig. 3
ool. Afr., XII, p. 11

subocular spot; proboscis and palpi darkened yellow. Thorax: dorsum black ferruginous, very faintly gray-dusted, with pale pubescence. Humeri, a broad mesopleural fascia separated from humeri by less than their width, just touching sternites and above a broad triangular patch on suture to dorsocentral line, and a double hypopleural spot, yellow; bristles black, normal, anterior supra-alar absent. Scutellum yellow with narrow blackish ferruginous base. Legs blackish ferruginous, joints paler, tarsi ferruginous, except metatarsi yellow. Halteres yellow. Wing: venation normal, a well-developed blackish costal margin from brown stigma, including base of first basal cell, and extreme base of submarginal, filling marginal, broadening from its tip to fill end of submarginal, slightly crossing end of third vein to end in a point on wing margin; anal cell and narrowly for two-thirds length of point on outer side, infuscated; point to remainder of sixth vein, in male, 5 to 2, in female, 5 to 4. Abdomen black ferruginous, last segment more or less reddish centrally, with oval areas darker; pubescence pale, longer than on thorax, on second segment a short transverse fascia slightly interrupted in middle, third segment ciliate in male, segments fused, sternites shining black ferruginous, membranes brown, genitalia ferruginous, base of ovipositor short, 0.5 mm, broadly conical, truncate, black ferruginous, only just visible from above.

Types.—Male and female, four male and three female paratypes, Addis Ababa, Abyssinia, Aug. 1, 1920. F. 4950.

Carpophthoromyia amæna (Enderlein)

This and *C. dimidiata* Bezzi, from South Africa, are certainly the same species. The South African form may be regarded as a variety having the apical half of the scutellum brown, while in *amæna* there is only a brown spot on the under side. Also in the South African specimens the inverted V-shaped hyaline band is always distinctly disconnected at the bend, while in *amæna* this only happens occasionally, although there is usually at least a faint connection.

Trirhithrum facetum (Enderlein)

Ceratitis faceta ENDERLEIN, 1920, Zool. Jahrb., XI, III, p. 349.

Trirhithrum facetum BEZZI, 1924, Bull. Ent. Res., XV, p. 105 (in tables).

A male, Lukolela, left bank Congo River, 1° 5' S., Jan. 13, 1931, J. P. Chapin.

There is little doubt that this specimen is a male of Enderlein's species, the only record of which is the female type. It agrees with the description, differing only in the feathering of the middle tibia, a male sexual character. In regard to the latter, the species is certainly a *Trirhithrum* with feathered tibiae rather than a black *Pterandrus*. Both *facetum* Enderlein and *bicinctum* Enderlein, however, seem very closely allied and the data available is really hardly enough to separate them. As stated, the male described here agrees with the description of the

female and differs from the latter, as redescribed by Bezzi,¹ in the absence of white hypopleural spots (at most that region is paler blackish or brownish), also in the absence of a brown bar across frons, and no narrow yellow band at base of scutellum. The whitish bands on second and fourth (NOT first and third) segments are not strongly developed, although moderate on fourth, but faint on second. The arista has rather short and fine plumosity; there are two inferior and two superior orbital bristles and strong ocellars; thoracic chaetotaxy normal, one mesopleural and dorsocentrals on line of anterior supra-alars. All femora concolorous with thorax, proximal ends of first tibiae blackened, rest of leg yellow, front femora rather swollen with lower and outer rows of bristles; middle femora simple, tibiae black, paler at ends, feathered along top edge and distal two-thirds of lower, and with a strong apical spine, tarsi yellow; hind femora more brown, a row of bristles along distal third below and along distal fifth above, these not quite developed into feathering, a silvery sheen on outer surface where pubescence apparently is strongly shining.

Trirhithrum inauratipes, new species

A fair-sized, black species, very similar in coloration of head and body and in wing pattern to the male of *T. facetum* just described, but strikingly different in the yellow, differently ornamented legs. As has been said, while there seems no doubt that the male just mentioned is that of *T. facetum* (Enderlein), the possibility of this being the male of that species may be excluded on account of the yellow legs, and there seems even less reason for connecting it with the female of *T. bicinctum* (Enderlein), not only on account of the color of the legs, but also owing to the absence of white hypopleural spots, of a bar across the frons and the mainly brown pleura. So far as *T. facetum* and *T. bicinctum* are concerned, both are described from the female only, but it certainly could be expected that in the males the femora at least would be blackish. At the same time there are some remarkable sexual differences among the Trypetidæ, so it cannot be said that the male described here as a new species could not be that of a described female. The only sure way to settle the question would be to rear the species.

MALE.—Length of body, 5.0 mm., of wing, 5.3 mm. Head: proportions of length, height and width, 4, 6, and a little more than 7; yellow, only upper part of occiput brown right across, ocellar dot brown and a slight brownish subocular spot. Occiput flat, not very prominent below. Frons about one-fifth longer than wide and

¹1924, Bull. Ent. Res., XV, p. 100.

less than one-third wider than an eye; flat, with slight sparse anteriorly; frontal bristles brown, two inferior and two superior or vertical plates short, fairly prominent; frontofacial angle obtuse. Antennae two-thirds length of face, situated at middle of somewhat narrowed to rounded apex, arista brown, short; cheeks narrowed, widening suddenly to genae, epistome not dorsum, scutellum, postscutellum and mesopleurum shining by pubescence, mesopleura obscure yellow; hind parts of pleura sternites, brownish black, rather less polished than dorsum; h centrals on line of anterior supra-alars. Legs yellow, only coxae swollen, with a brush of long golden-yellow bristles and hairs; shorter hairs posterodorsally; middle femora very slightly blue groove well developed, brown on its proximal half, on each side black incurved hairs; anteriorly, just above and along tibial a slightly concave area which in oblique light is shining silvery, row of five or six bristles curved over it; on tibia distally a r bristle-hairs on dorsal two-thirds and of longer blacker wider-sq half; a strong apical spine present; hind femora distally with and of ventral bristle-hairs not quite developed into leather Scutellum swollen, with longer pubescence and four bristles. Wi veins black, but brown at base; base of wing black with a fe bands black, basal united to marginal, middle absent, cubital sq united to basal, axillary cell blackish. Abdomen black, shin polished, gray band on second segment slight, stronger on four white on gray bands, fourth and fifth segments yellowish medially

TYPE.—Male, Lukolela, left bank Congo River, 1° 5' S., Chapin.

Ceratitis (Pardalaspis) lentigera, new sp

A small species of *Pardalaspis* with spotted and variously different from *P. punctata* (Wiedemann), smaller size and in a different arrangement of the tables it appears to run to *P. giffardi* Bezzi, but it is largely closely allied to this species. Apart from the bluish or whitish bands as in *P. giffardi* and other spe

MALE, FEMALE.—Length of body: male, 4.2 mm., female, male, 4.1 mm., female, 4.3 mm. Head: proportions of length approximately 6, 8, and 11, light brownish yellow. Occiput flat large brown spots, moderately prominent below. Frons parallel eye and two-thirds length, light brownish, rather darker on inner plates and around brown ocellar dot. An irregular transverse band line of upper inferior orbital but not touching them nor orbits (b A brown spot on each side at base of antennae more or less or female more strongly developed as a transverse bar). Very black pubescence anteriorly; bristles black except postvertical and i

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AMPHIPODA FROM FLORIDA AND THE WEST INDIES

By CLARENCE R. SHOEMAKER

This paper is based upon specimens which have been collected from time to time in Florida, for The American Museum of Natural History, by Dr. F. E. Lutz, Mr. Wm. Wheeler, Dr. W. G. Van Name, and Mr. A. J. Mutchler; in Cuba by Mr. Barnum Brown; in Dominica, West Indies, by Dr. F. E. Lutz, and Dr. R. W. Miner; in Martinique, Barbados, and Trinidad by Mr. P. B. Whelpley; and in British Guiana by Dr. F. E. Lutz. One of the specimens of *Leucothoe spinicarpa* was taken by the United States Fisheries steamer 'Albatross' in the Gulf of Mexico.

The collection is represented by ten families, fourteen genera, one of which is new to science, and seventeen species, five of which are new to science. Any extension of knowledge of the little-known amphipod fauna of the West Indies is very acceptable and this collection, though small, contains several important additions.

GAMMARIDEA

Lysianassidae

Lysianopsis alba Holmes

Figure 1

Lysianopsis alba HOLMES, 1903, Amer. Naturalist, XXXVII, p. 276; 1905, Bull. Bureau of Fisheries for 1904, XXIV, p. 475, Fig.

TYPE LOCALITY.—Woods Hole, Mass.

DISTRIBUTION.—Southern New England to Porto Rico and the Tortugas.

SPECIMENS COLLECTED.—One; off Key Largo, Florida, May, 1904, Wm. Wheeler.

As I have pointed out before, this species has been confused with *Lysianassa cubensis* (Stebbing) to which it bears a very close superficial resemblance. The principal distinguishing characters of the two species lie in the mouth-parts and the second gnathopods. The molar of the mandible is low and oblique with the posterior end produced into a rough spinulose process; spine-row with four spines. Maxilla 1 with inner plate long and tapering end bearing two long apical setæ; outer plate with the very obliquely truncate and bearing eleven serrate spine-teeth. Maxilla 2 with inner plate narrow end pointed and having a row of spines on upper third of inner margin; outer plate slightly longer than

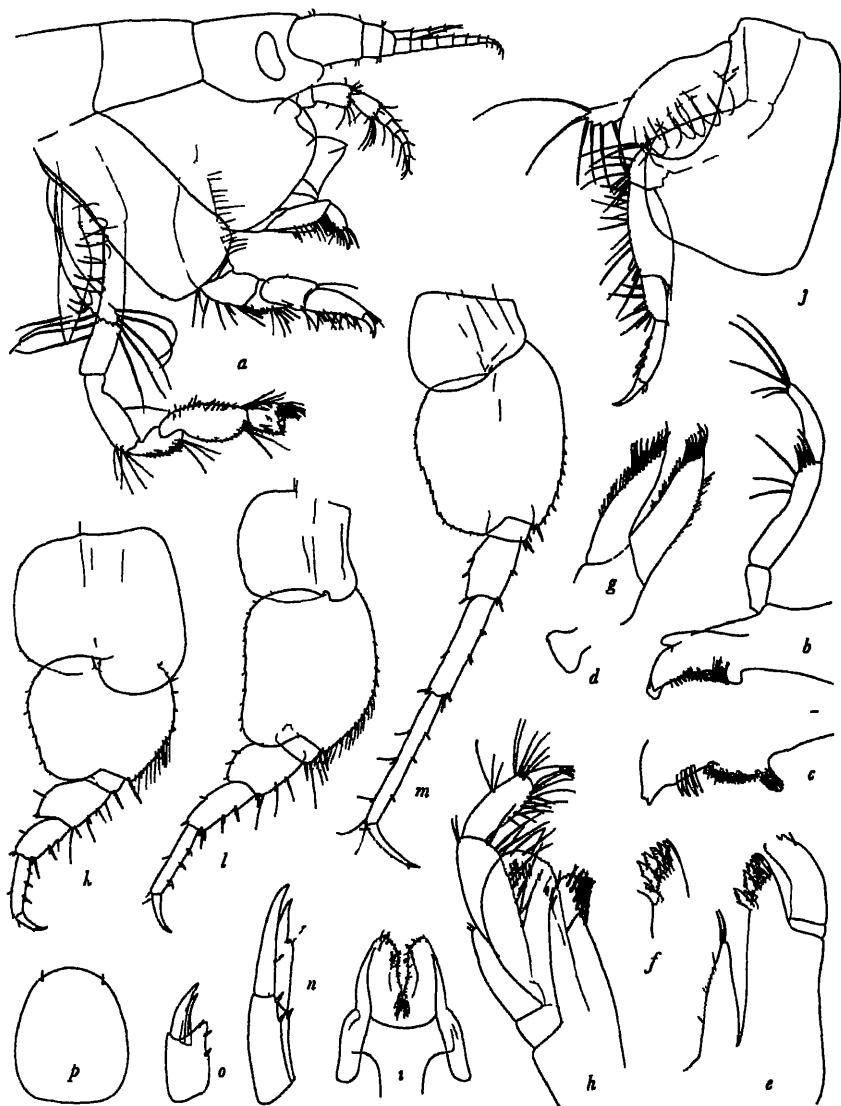


Fig 1. *Lysianopsis alba* Holmes, drawn from a male from the type lot
a, the anterior end of the animal, b, mandible c, molar and spine-row from a Tortugas specimen,
d, cutting-edge of mandible, e, maxilla 1 f, end of outer plate of maxilla 1 g, maxilla 2 h, maxilliped
i, lower lip j, pereopod 2, k, pereopod 3, l, pereopod 4 m, pereopod 5, n, uropod 2, o, uropod 3,
p, telson

inner with a row of curved spines on the obliquely truncate end. Maxillipeds with inner plate narrowing distally and bearing three apical teeth; outer plate broadly oval with upper part of inside edge somewhat crenulate, but without teeth. Lower lip with lobes obliquely truncate; mandibular processes long and blunt.

Ampelisca

Ampelisca holmesii Pearse

Ampelisca holmesii PEARSE, 1908, Proc. U. S. Nat. Mus., XXXIV, No. 1594, p. 27, Fig. 1.

TYPE LOCALITY.—Ferguson's Pass, Oyster Bay, Florida.

DISTRIBUTION.—There are in the collection of the U. S. National Museum specimens from Rhode Island; Connecticut; Beaufort, North Carolina; Key West, Florida; and Sarasota Bay, Florida.

SPECIMENS COLLECTED.—Twelve; off Key Largo, Florida, May, 1904, Wm. Wheeler.

Ampelisca spinipes Boeck

Ampelisca spinipes BOECK, 1861, Forh Skand. Naturf., Møde VIII, p. 653. SCHELLENBERG, 1925, Meeresfauna Westafrikas, III, Lief. 4, p. 128. STEPHENSEN, 1925, 'Danish Ingolf-Exped.', III, pt. 9, Crustacea Malacostraca. VI (Amphipoda. 2), p. 146.

TYPE LOCALITY.—West coast of Norway.

DISTRIBUTION.—Coast of Norway north to Lofoten Islands; North Sea; France; Gulf of St. Lawrence; New England coast; and Gorée, Senegal.

SPECIMENS COLLECTED.—One; off Key Largo, Florida, May, 1904, Wm. Wheeler.

This is the first record of the occurrence of this species in Florida.

Ampelisca schellenbergi, new species¹

Figure 2

TYPE LOCALITY.—'Albatross' station 2369-2374, 29° 18' N., 85° 32' W., Gulf of Mexico, 25 fathoms, February 7, 1885. Type in the U. S. National Museum; Cat No. 65434.

DISTRIBUTION.—Off Apalachicola and Tampa, Florida, taken by the 'Albatross'; off Charlotte Harbor and east Bahia Honda Bay, Florida, taken by the 'Fish Hawk'; Tortugas, Florida, taken by Dr. W. L. Schmitt; off Yucatan, taken by the 'Albatross.'

SPECIMENS COLLECTED.—One; off Key Largo, Florida, May, 1904, Wm. Wheeler.

DESCRIPTION OF MALE.—The upper lateral front of head slightly concave, lower lateral front oblique and below the eye convex; lower eye situated slightly below the lateral angle. Antenna 1 reaching very little beyond peduncle of antenna 2; flagellum has about sixteen joints. Antenna 2. fifth joint of peduncle a little over two-

¹Named in honor of Dr. A. Schellenberg, the eminent German carcinologist.

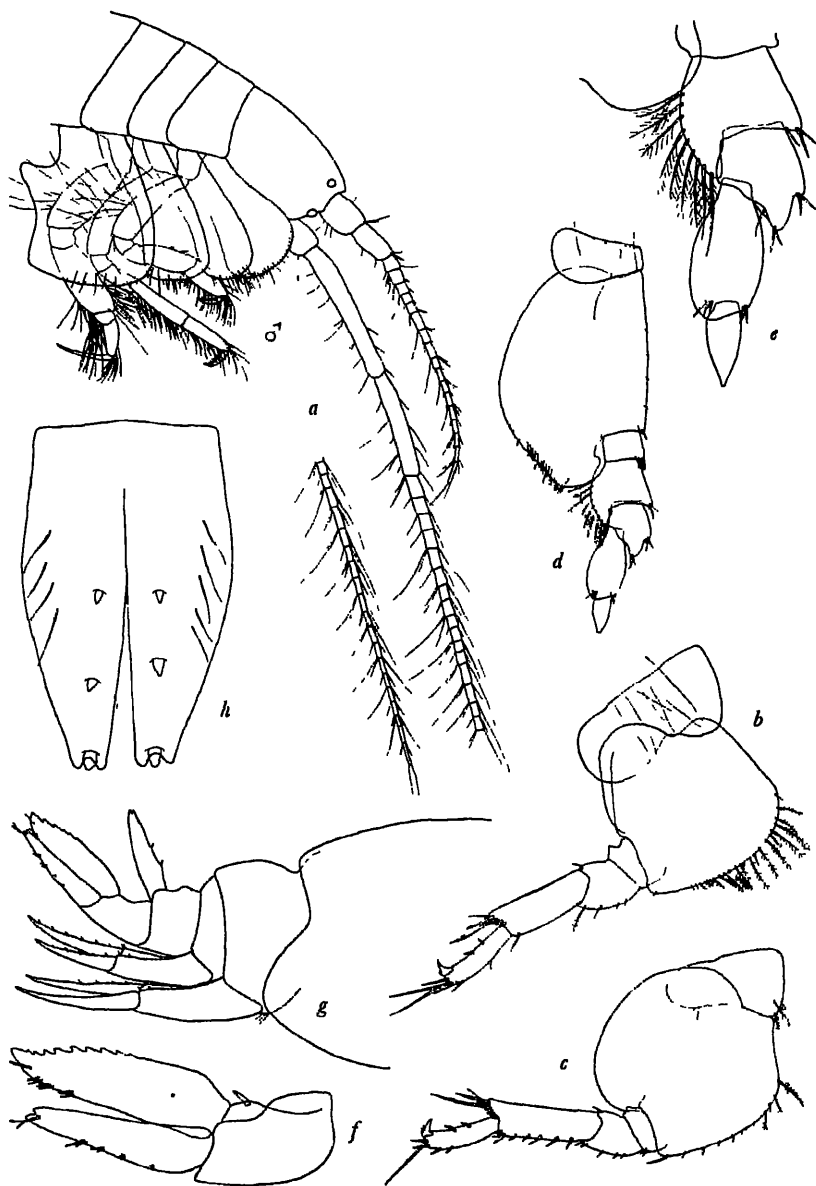


Fig. 2. *Ampelisca schellenbergi*, new species, male
 a, anterior half of animal; b, perseopod 3, c, perseopod 4; d, perseopod 5, e, distal end of perseopod 5, much enlarged, f, uropod 3; g, posterior end of animal, h, telson.

thirds the length of the fourth; flagellum composed of about thirty-five joints. Side-plate 1 considerably expanded below, front margin slightly concave above, lower margin broadly rounding. Gnathopods 1 and 2 and pereopods 1 and 2 normal. Pereopod 3: second joint with hind margin very broadly lobed; fifth joint much stouter than sixth and bearing an oblique row of stout spines on lower hind margin; seventh joint with two backward-pointing teeth on lower margin. Pereopod 4: second joint with hind margin very broadly and evenly lobed, fifth joint much stouter than sixth, bearing an oblique row of stout spines on lower hind margin, and a row of short spines on front margin; seventh joint with two backward-pointing spines on lower margin. Pereopod 5: second joint with lower posterior margin oblique and lower margin evenly and rather narrowly lobed; fourth joint, lower hind margin produced downward into a narrow lobe as deep as the hind margin of the fifth joint; fifth joint with front margin much deeper than hind margin and bearing a very pronounced notch and two spines just below center; sixth joint much broader than usual with front and hind margins convex; seventh joint stout, converging to a blunt point. Pleon segment 3: posterolateral corner evenly rounding and lateral margin slightly convex. Pleon segment 4 bearing saddle-shaped dorsal depression. Uropod 3: outer ramus noticeably shorter than inner, distally notched and bearing a few spinules on outer margin and two near the apex; inner ramus much broader than outer, bearing a series of coarse teeth on the distal half of inner margin and a few spinules on distal portion of outer margin. Telson: apices of lobes notched and each notch bearing a short blunt spine; two short, blunt spines and a few slender setae on upper surface of each lobe.

LENGTH.—11 mm.

Phoxocephalidae

Pontharpinia floridana, new species

Figures 3, 4

TYPE LOCALITY.—Off Key Largo, Florida, May, 1904, Wm. Wheeler. Type in The American Museum of Natural History; Cat. No. 6691

DISTRIBUTION.—There are in the collection of the United States National Museum specimens from Skull Creek, South Carolina, taken by the 'Fish Hawk,' and also from 'Fish Hawk' station 8250, sixteen miles off Sable Island light-house, Georgia, May 3, 1915.

SPECIMENS COLLECTED.—Six; off Key Largo, Florida, May, 1904, Wm. Wheeler.

DESCRIPTION OF MALE. Head elongate, rostrum slightly spatulate, reaching somewhat beyond the middle of the second joint of antenna 1, lateral margin produced to a rather sharp angle in front of the eyes, postantennal angle quadrate, eyes large and black. Antenna 1: second joint about two-thirds the length of the first; third joint one-half the length of the second; flagellum composed of about ten joints, the first four or five of which carry calceoli. Antenna 2: fourth and fifth joints broad; flagellum reaching nearly the length of the body and carrying calceoli. Mandible with nine spines in spine-row, molar rather low, lacking the triturating surface and tipped with six rather stout spines. Maxilla 1: inner plate tipped with several spines and one plumose seta; outer plate bearing eleven toothed spine-teeth; palp bearing five stout and two slender spines on the oblique apex. Maxillipeds proportioned as figured by Sars for *Phoxocephalus holbüllii*; outer plate bearing five spines on inner

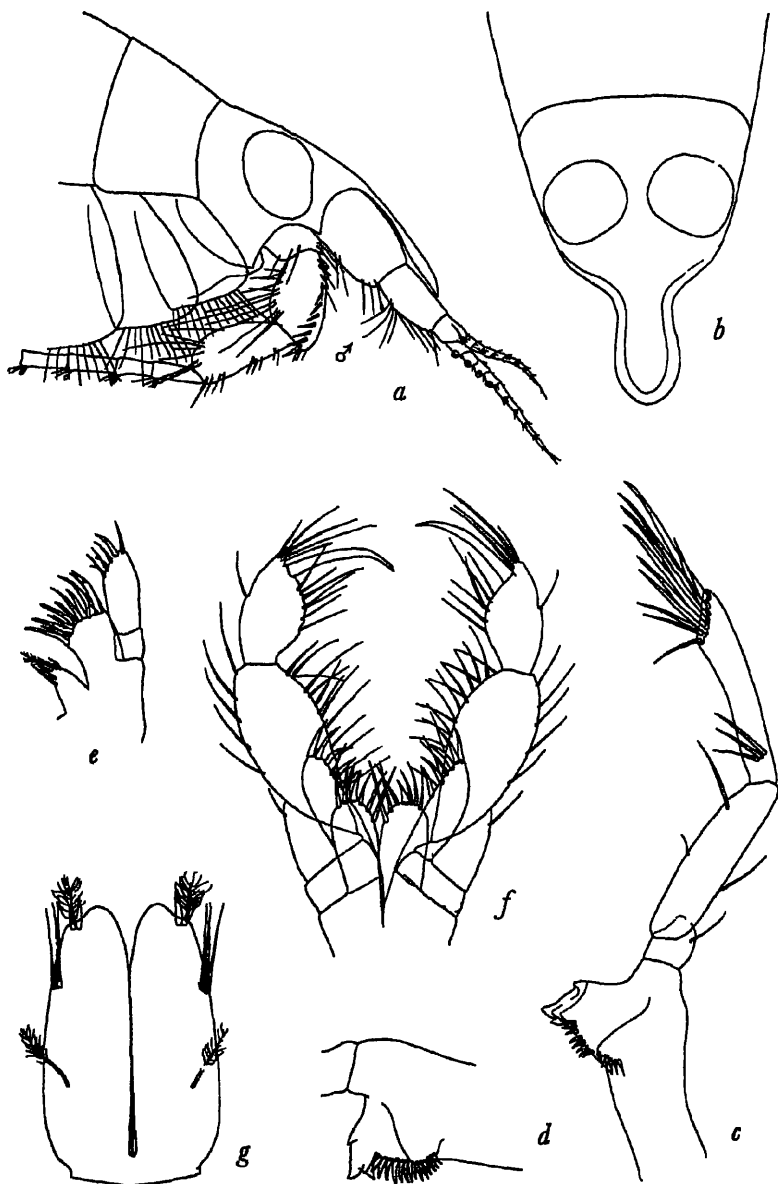


Fig. 3 *Pontharpina floridana*, new species, male.
a, anterior end of animal b, dorsal view of head, c and d, right mandible, e, maxilla 1, f, maxilliped, g, telson

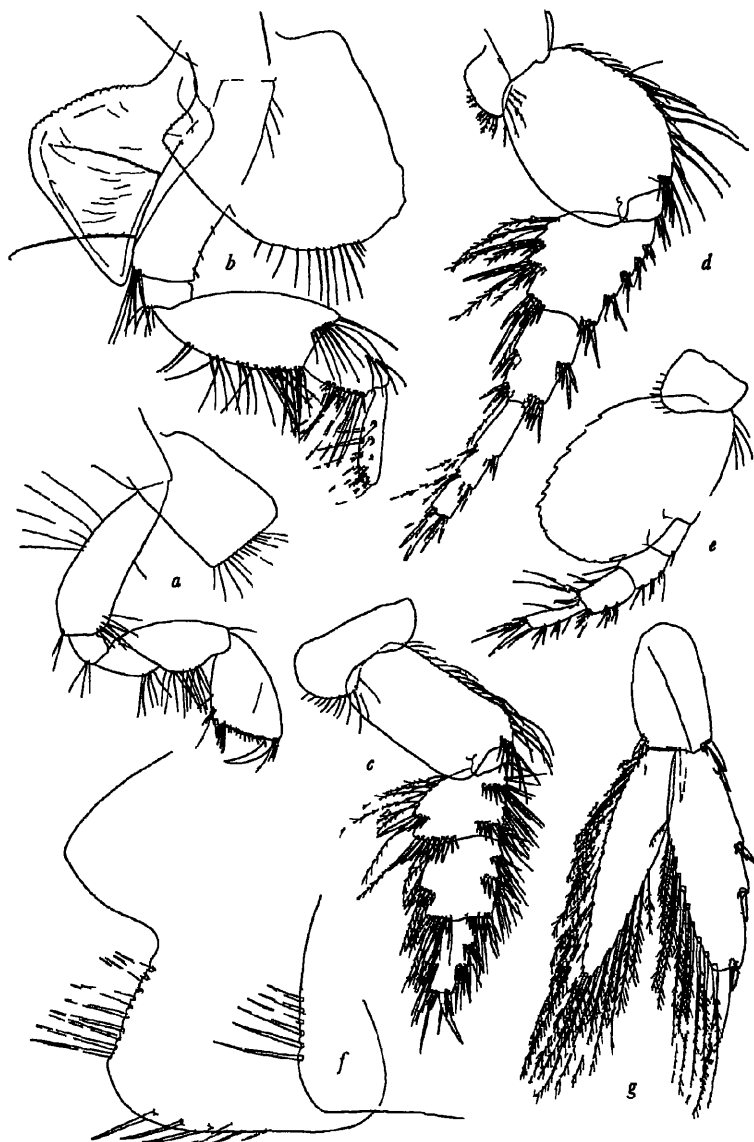


Fig. 4 *Poniharpina floridana*, new species male.
 a, gnathopod 1, b, pereopod 2 c, d, and e, pereopods 3, 4, and 5 drawn on a slightly smaller scale
 than gnathopod 1 and pereopod 2 f, pleon segments 2 and 3 g, telson

margin; inner plate bearing six spines and a long tooth on rounding apex. Gnathopod 1: fifth and sixth joints equal in length; sixth joint, palm oblique, defined by a low protruding angle and a stout spine and armed throughout with rather weak curved spinules; seventh joint fitting palm. Gnathopod 2 like 1 except that the second, third, and fourth joints are slightly longer and the fifth and sixth slightly shorter than in gnathopod 1. Peraeopods 1 and 2 alike: fourth joint expanded distally; fifth narrowing distally; sixth slender, slightly longer than fifth, considerably constricted at proximal end; fifth and sixth joints bearing many stout spines on posterior surface; fourth joint bearing groups of slender spines on posterior surface. Peraeopod 3: fourth joint expanded quite as much as second, fifth expanded somewhat less than fourth; sixth much narrower than fifth, seventh very slender; fourth, fifth, and sixth bearing many spines and setae. Peraeopod 4: fourth joint much expanded; fifth little expanded; sixth about normal; seventh slender; fourth, fifth, and sixth joints bearing many spines and setae. Peraeopod 5. second joint expanded downward to about the middle of the fifth joint; sixth joint slender and noticeably constricted near the proximal end. Pleon segment 3. lower posterior corner broadly rounded, posterolateral margin and lower margin bearing a row of spines; pleon segment 2 with corner less rounding and fewer spines on lateral margin. Uropod 1 reaching to about the middle of the rami of uropod 3, peduncle without spines on upper outer edge except a single one at distal extremity, about four spines on outer ramus and one on inner in addition to a backward-pointing spine at their apices. Uropod 2 reaching to about the middle of the rami of uropod 1: peduncle with a row of comparatively long spines on upper outer margin; outer ramus bearing four spines in addition to the backward-pointing distal spine. Uropod 3. rami about twice as long as peduncle, expanded, outer bearing two groups of spines on outer margin and a row of long plumose setae on inner, second joint narrow, about one-third the length of first and bearing two long apical spines, inner ramus a little longer than the first joint of the outer, and bearing long plumose setae on both margins. Telson extending back about one-fourth the distance along the rami of uropod 3, cleft to base, inner corner of apices rounding, outer corner depressed and bearing two spines and a plumose seta, a group of long spines on outer margin about one-third the distance from the distal end and a plumose seta about one-third the distance from the proximal end.

LENGTH.—Type measures 6 mm, but specimens from Georgia are 8 mm. in length.

Leucothoidae

Leucothoe spinicarpa (Abildgaard)

Gammarus spinicarpus ABILDGAARD, 1789, O. F. Müller, 'Zool. Dan.,' 3d Ed., III, p. 66, Pl. CXXIX, figs. 1-4.

Leucothoe spinicarpa, *L. articulosa* (error) G. O. SARS, 1892, 'Crustacea of Norway,' I, p. 283, Pl. c; Pl. CI, fig. 1.

Leucothoe spinicarpa SCHELLENBERG, 1931, 'Swedish Antarctic Exped., 1901-1903,' II, No 6, p. 92.

TYPE LOCALITY.—Northern shore of the island of Zealand.

DISTRIBUTION.—This is a cosmopolitan species and its records include the Arctic and Antarctic regions. It occurs frequently in ascidians.

SPECIMENS COLLECTED—One; 'Albatross' station 2405, 28° 45' N, 85° 02' W., Gulf of Mexico One; Boca Caya Bay, Florida, March, 1916, W. G. Van Name Five; Paradoes opposite Cayo Carena, six miles south of Cienfuegos, Cuba, June 18, 1918, Barnum Brown.

Oedicerotidae

Monoculodes nyei, new species¹

Figure 5

TYPE LOCALITY—Key West, Florida, 1884, 'Albatross,' electric light, collected by Willard Nye, Jr. Type in the U S National Museum; Cat. No. 65458.

DISTRIBUTION—Eleven specimens of this species were taken by Dr. Waldo L. Schmitt at Villa Bella, Ilha São Sebastião, Brazil, in September, 1925, while travelling under the Walter Rathbone Bacon scholarship of the Smithsonian Institution. There are also specimens from Key West, Florida, in the National Museum Collection, and the specimens dealt with in the present paper are from Key Largo, Florida.

SPECIMENS COLLECTED—Two; off Key Largo, Florida, May, 1904, Wm. Wheeler.

DESCRIPTION OF MALE—Head with frontal process very short and blunt and deflexed rather abruptly at a right angle, lateral angle obtuse, but not at all rounding. Eyes large, oval, apparently united above and occupying almost all the frontal process. Antenna 1 very short, the peduncular joints becoming successively shorter, flagellum slightly shorter than peduncle and very plumose, first joint as long as the remaining four combined. Antenna 2: peduncle about two-thirds the length of the flagellum, last joint of peduncle and those of the flagellum armed on upper surface with minute hooked spines. Gnathopod 1 nearly as figured by Sars for *M. longirostris* (Göts.)² but the lobe of the fifth joint is narrower and proportionately longer. Gnathopod 2 nearly as figured by Sars for *M. carinatus* Bate,³ but sixth joint becomes slightly narrower distally and the palm is more oblique, the fifth joint terminates in a slightly inward-turning point at the side of which is a single stout spine. Peraeopods 1 and 2: sixth joint almost transversely truncate and bearing several groups of long curved spines, dactyl about two-thirds the length of the sixth joint. Peraeopods 3 and 4 about normal, dactyl equal in length to sixth joint. Peraeopod 5. second joint as broad as long, hind margin almost evenly convex and very slightly lobed at lower corner, from the inside of which spring two long plumose setae; seventh joint equal in length to sixth, front margin furnished with five or six groups of long, slender, simple setae, and terminating in two slender spines, one much longer than the other. Uropod 2 extending backward slightly farther than 1 or 3. Telson very slightly emarginate and bearing a plumose setule at either rounded corner.

LENGTH.—4 mm.

The specimen figured is a male collected by Dr. Waldo L. Schmitt at Villa Bella, Ilha São Sebastião, Brazil, in September, 1925.

¹Named in honor of Mr. Willard Nye, Jr., who was naturalist on the 'Albatross' in 1884, and who collected the first specimens.

²Crustacea of Norway, I, Pl. oviii, fig. 3 p¹

³Crustacea of Norway, I, Pl. ov, fig. p⁴.

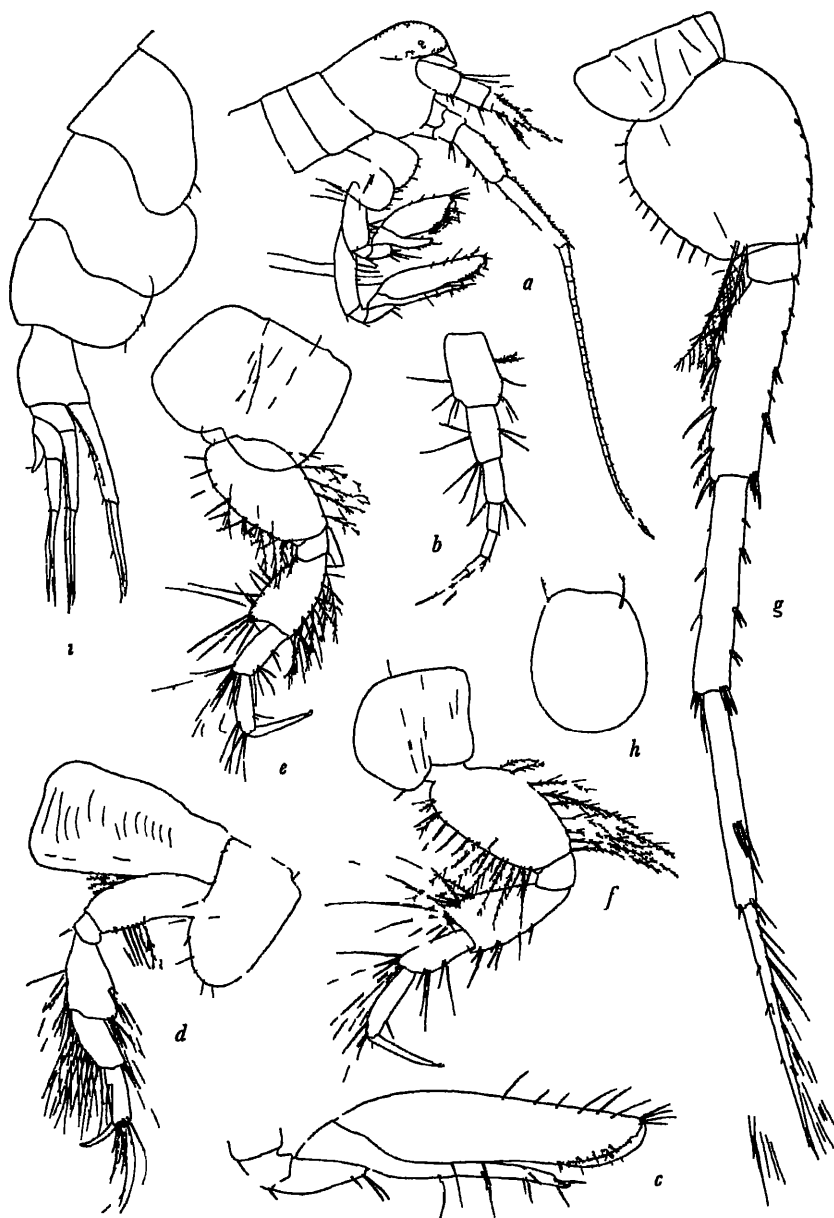


Fig 5 *Monoculodes nyet*, new species, male
 a, anterior end of animal, b, antenna 1 female c gnathopod 2 much enlarged, d, pereopod 1,
 e, pereopod 3 f pereopod 4 g pereopod 5 h, telson i posterior end of animal

Synopiidae

Synopia ultramarina Dana

Synopia ultramarina + *S. gracilis* J. D. DANA, 1853 and 1855, 'U. S. Explor. Exped.,' XIII, pt 2, p 995; Pl. LXVIII, figs. 6a-h, 7a-e.

Synopia schælcana BOVALLIUS, 1886, Nova Acta Soc. Sci., Upsal., (3) XIII, No. 9, p 16, Pl. II, figs. 22-29.

Synopia ultramarina SCHELLENBERG, 1926, 'Deutsche Südpolar-Exped., 1901-1903,' Die Gammariden, p 341, Fig. 49 (synonymy); 1929, Bull. of the Mus. Comp. Zool., LXIX, No. 9, p. 200. BARNARD, 1930, 'British Antarctica ("Terra Nova") Exped., 1910,' Nat. Hist. Report, Zool., VIII, No. 4, p 367.

TYPE LOCALITY.—Tropical Atlantic, 8°-12° S. and 11°-14° W.

DISTRIBUTION.—Tropical Atlantic to 41° N. and 18° S.; Gulf of Mexico, off Cuba (specimens in U. S. Nat. Mus. Collection); tropical Pacific; and Indian Ocean.

SPECIMENS COLLECTED.—Sixteen; off Key Largo, Florida, May, 1904, Wm. Wheeler.

Bateiidae

Carinobatea cuspidata Shoemaker

Carinobatea cuspidata SHOEMAKER, 1926, Proc. U. S. Nat. Mus., LXVIII, Art. 25, p. 21, Figs. 14, 15

TYPE LOCALITY.—Saint Thomas, Virgin Islands.

DISTRIBUTION.—Saint Thomas, Virgin Islands; west coast Florida; Porto Rico.

SPECIMENS COLLECTED.—Three; off Key Largo, Florida, May, 1904, Wm. Wheeler.

Gammaridae

Pseudoceradocus, new genus

TYPE LOCALITY.—Georgetown, British Guiana, July 3, 1911, Dr. F. E. Lutz. Fifteen specimens collected.

GENERIC CHARACTERS.—Head without conspicuous rostrum. Side-plates 1-4 equal in depth and deeper than fifth, fourth excavate behind. Branchial vesicles simple and without accessory branchiae. Marsupial plates narrow. Antenna 1 longer and slenderer than 2, accessory flagellum well developed. Antenna 2: gland-cone very prominent, flagellum short. Upper lip with rounded margin. Lower lip with inner lobes. Mandible: third joint of palp longer than second. Maxilla 1: inner plate large, margin fringed with numerous setae, outer plate with nine spines, palp armed distally with seven spines and several setae. Maxilla 2: inner plate fringed along inner margin. Maxillipeds: inner and outer plates rather short, palp very strong and well developed, second and third joints subequal in length. Gnathopods subchelate, gnathopod 2 much stouter than 1. Uropod 1 reaching farther back than 2. Uropod 3 very large, rami subequal and foliaceous. Telson deluscent, cleft to base.

Pseudoceradocus lutzi, new species¹

Figures 6, 7

TYPE LOCALITY —Georgetown, British Guiana Type in The American Museum of Natural History; Cat No. 6692

DESCRIPTION OF MALE —Head: side-lobes rather flat, separated from lower margin by a deep incision Eyes much constricted in center, sometimes even being divided into two parts Antenna 1: peduncle much shorter than flagellum, first joint a little shorter than second, flagellum composed of about thirty-five joints, accessory flagellum reaching beyond sixth joint of primary flagellum and composed of six joints Antenna 2: peduncle long and stout, fourth and fifth joints equal in length, flagellum composed of about twenty joints and about equal in length to fifth peduncular joint. Mandible: six spines in spine-row, molar very strong and prominent and having on the side nearest the spine-row a stout accessory masticatory process, first joint of palp about two-thirds the length of the second, third joint longer than second, second joint bearing two short distal spines and the third joint two long terminal spines Maxilla 1: inner plate very broad, margined throughout by plumose setae and bearing a submarginal row of eight or nine slender spines, outer plate bearing nine stout curved serrate spines, palp with seven terminal short stout spines and a few setae Maxilla 2: inner margin of inner plate with a double row of setae, outer plate with double row of terminal spines. Maxillipeds, inner and outer plates rather short, inner plate reaching to about the middle of outer plate and bearing three terminal spine-teeth, outer plate reaching to one-third the length of the first joint of the palp, upper half of inside margin bearing a row of spine teeth, palp robust, third joint very nearly as long as second, fourth joint nearly as long as third, bearing a terminal nail and seta and a row of very fine setules on inner margin. Lower lip with rather weakly-developed pubescent inner lobes, mandibular processes rather short and rounding Side-plate 1 not produced forward, lower margin evenly rounding and bearing a spine at the hind corner. Side-plates 2 and 3 also evenly rounding below and bearing a spine at hind corner. Side-plate 4 excavate behind so as to fit the front margin of side-plate 5 Gnathopod 1 slender, second joint about equal in length to the depth of the side-plate, fifth joint longer than sixth with the broadly lobed hind margin furnished with transverse rows of setae, sixth joint rectangular but slightly narrowing distally, hind margin with transverse rows of serrate spines, palm transverse, very convex and undefined, seventh joint curved to fit palm, very stout at base but becoming very slender toward apex Gnathopod 2 robust, second joint subequal in length to sixth, fifth joint short, sixth joint strong and stout, widest proximally, hind margin with groups of spines, palm very oblique, defined by a group of stout spines, a stout rounding process bearing about six distal spines adjacent to the hinge of the seventh joint, the area between the process and the defining spines occupied by a soft membranous cushion, seventh joint stout, nearly straight and equaling the palm in length. Peraeopods 1 and 2 about as in *Mera* and *Melita* Peraeopod 3 about the length of peraeopod 1. Peraeopods 4 and 5 considerably longer than the preceding, 5 the longest. Peraeopods 3 to 5: second joint expanded with hind margins serrate. Pleon segments 1 to 3 with lower hind corner very slightly produced. Pleon segment 4 in the young males and the females with two posterodorsal spines, and pleon segment 5 in young males and the females with four posterodorsal spines. These spines become lost or so greatly

¹Named in honor of Dr F E Lutz of The American Museum of Natural History.

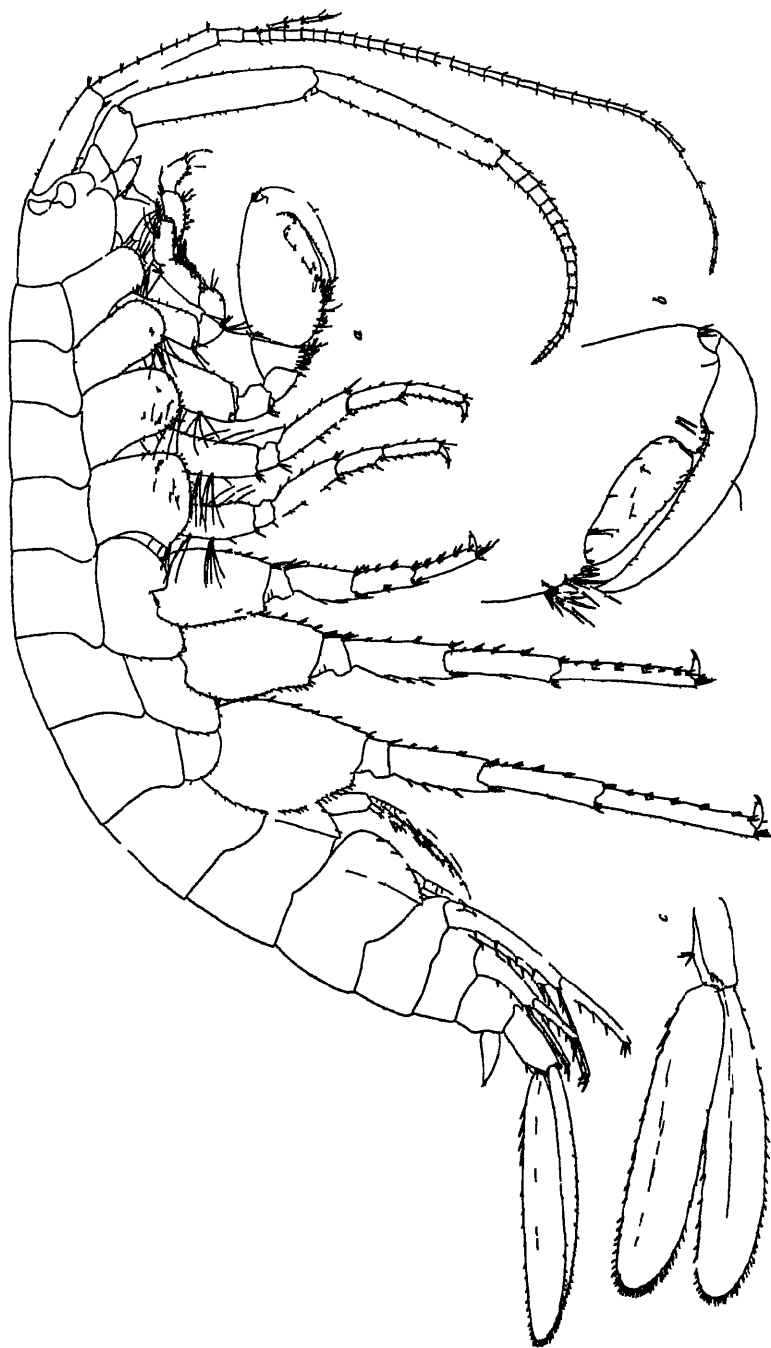


Fig 6 *Pseudoceradocus lutz*, new genus and species, male
 a entire animal b palm and seventh joint of gnathopod 2 greatly enlarged c uropod 3

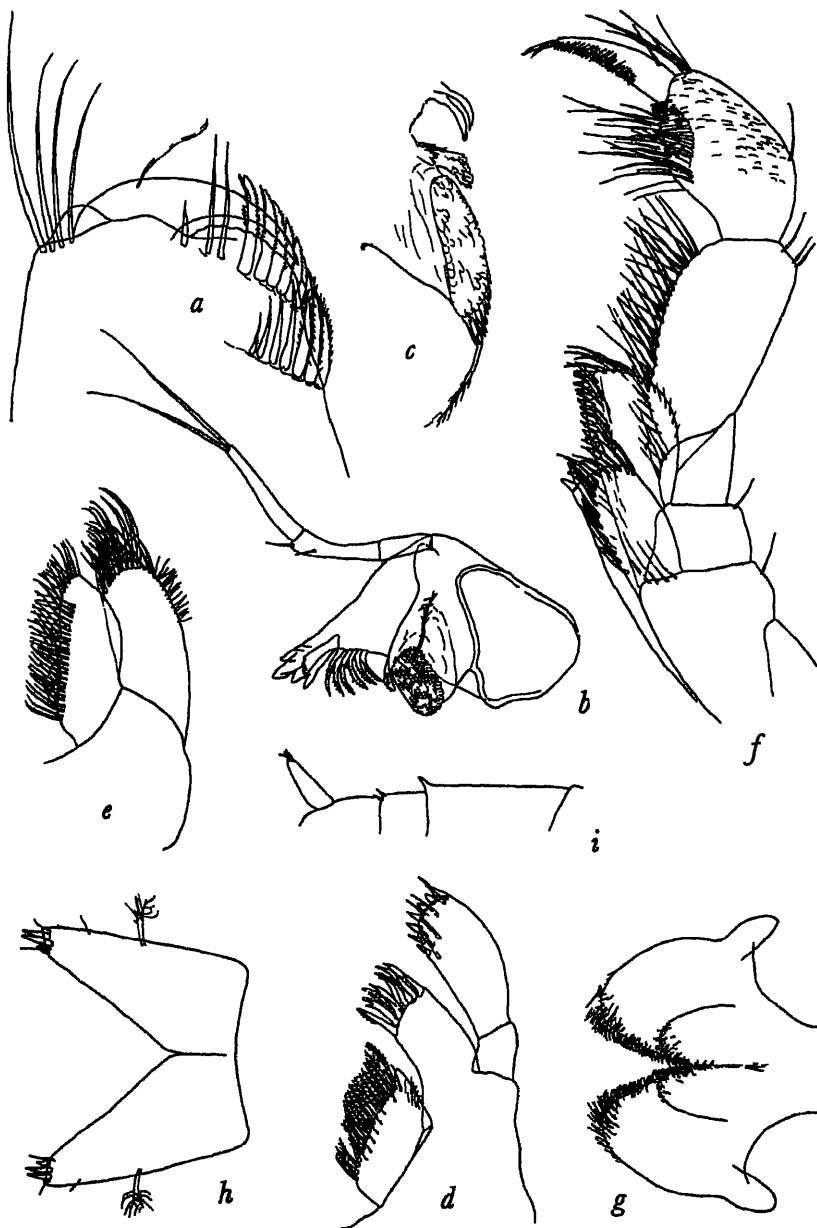


Fig 7. *Pseudoceradocus lutsi*, new genus and species, male.

a, gnathopod 1, greatly enlarged; *b*, right mandible, *c*, molar of right mandible showing the accessory masticatory process, *d*, maxilla 1; *e*, maxilla 2, *f*, maxilliped, *g*, lower lip, *h*, telson, *i*, pleon of younger male showing the dorsal spines of the fourth and fifth pleon segments

reduced in the older males as to be scarcely noticeable. Uropod 1: peduncle longer than rami of which the inner is slightly the longer. Uropod 2: peduncle about equal in length to inner ramus which is longer than outer. Uropod 3: peduncle reaching to end of inner ramus of pereopod 2, rami subequal in length, broad, flat, very thin, terminally rounding, edged with short spinules, and three or four times the length of the peduncle. Telson reaching to about the end of peduncle of uropod 3, cleft to base, lobes very widely divergent, each converging to an obliquely truncated apex armed with three short spines and a few setules, lateral margins bearing a group of two plumose setules at center and a short setule near apex. In the younger males and the females these terminal spines appear to be much longer proportionally.

LENGTH—11 mm.

The females are much like the males in general. In gnathopod 2 the sixth joint is not so large and strong, the palm is evenly and slightly convex and is without either the protuberance near the hinge or the membranous cushion. Uropod 3 is proportionally much shorter. In length the females are several millimeters shorter than the males.

Elasmopus rapax Costa

Figure 8

Elasmopus rapax COSTA, 1853, Rend. Soc. Borbon., (N Ser) II, p. 175. G. O. SARS, 1894, 'Crustacea of Norway,' I, p. 521, Pl. CLXXXIII. STEBBING, 1906, 'Das Tierreich,' Amph., I, p. 444. PEARSE, 1912, Proc. U. S. Nat. Mus., XLIII, No. 1936, p. 370. SCHELLENBERG, 1926, 'Deutsche Südpolar-Exped., 1901-1903,' Die Gammariden, p. 364.

TYPE LOCALITY.—Gulf of Naples.

DISTRIBUTION.—North Atlantic; South Atlantic; Mediterranean; Gulf of Mexico; Indian Ocean; Zanzibar; Red Sea; and South Pacific.

SPECIMENS COLLECTED.—One; bay shore of Plantation Key, southeast coast Florida, March 14, 1916, on Mangrove roots, W. G. Van Name. One; Paradones, opposite Cayo Carena, six miles south of Cienfuegos, Cuba, June 18, 1918, Barnum Brown.

The specimen from Florida which appears to be a female is quite typical except that the telson is not cleft, which of course is an abnormality.

Eucrangonyx gracilis (Smith)

Figure 9

Crangonyx gracilis S. I. SMITH, 1871 (and A. E. Verrill), Amer. Journal Science, (3) II, p. 452. SMITH, 1874, Report U. S. Fish Commission for 1872 and 1873, p. 654. FORBES, 1876, Bull. Ill. State Lab. Nat. Hist., No. 1, p. 6. O. P. HAY, 1882, Amer. Nat., XVI, p. 241; HAY, 1891, Proc. Indiana Acad. Sci., p. 150. DELLA VALLE, 1893, Fauna und Flora, Neapel, XX, p. 682. CHILTON, 1894, Trans. Linn. Soc. Lond., (2) VI, p. 218. BLATCHLEY AND HAY, 1896, Rep. Indiana Geol. Survey, p. 206. BANTA, 1907, Carnegie Inst. of Washington, Publication No. 67, p. 78 'The Fauna of Mayfields Cave.'

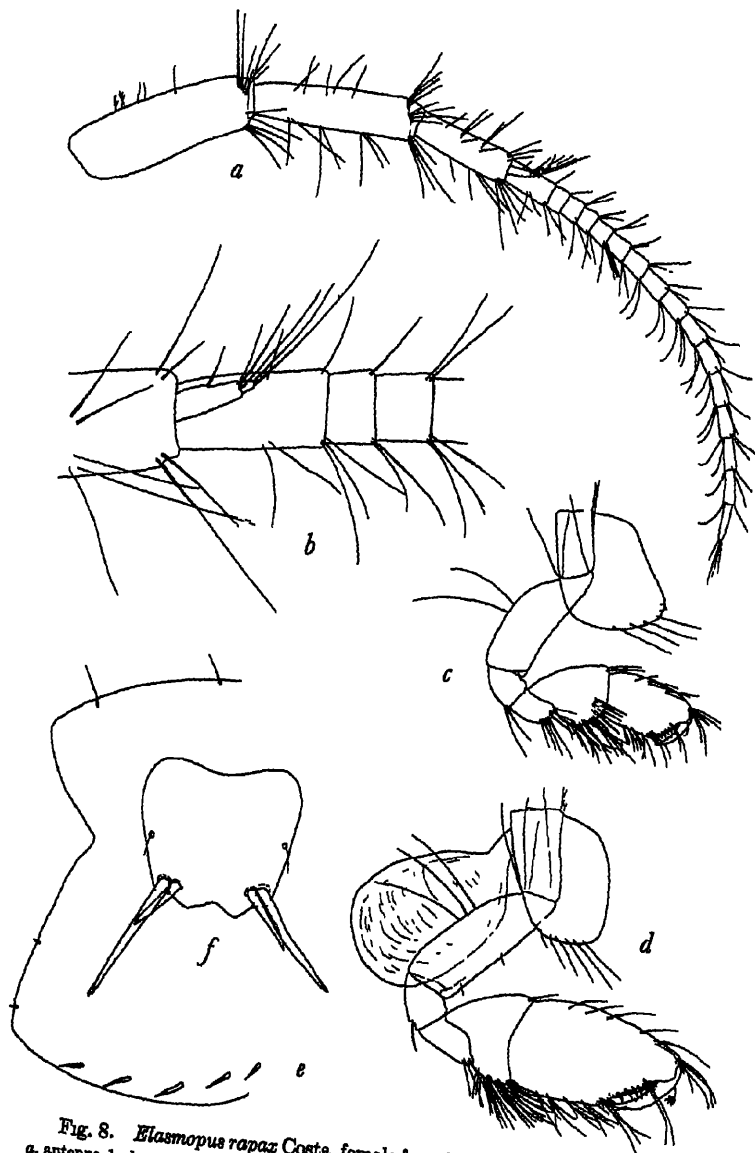


Fig. 8. *Elasmopus rapax* Costa, female from Plantation Key, Florida.
 a, antenna 1; b, accessory flagellum, greatly enlarged, c, gnathopod 1, d, gnathopod 2, e, pleon
 segment 3, f, telson.

Eucrangonyx gracilis STEBBING, 1899, Trans. Linn. Soc. Lond., VII, pt. 8, p. 423. WECKEL, 1907, Proc. U. S. National Mus., XXXII, No. 1507, p. 32, Fig. 3. NORTON, 1909, Proc. Portland Soc. Nat. Hist., II, p. 249. HUNTSMAN, 1915, Contributions to Canadian Biol., 1911-1914, pt. 2, p. 152, Fig. 4c. KUNKEL, 1918, Conn. State Geol. and Nat. Hist. Survey, Bull. No. 26, p. 94, Fig. 20. JOHANSEN, 1925, Canadian Field Naturalist, XXXIX, No. 8, pp. 138-139. CREASER, 1931, Ecology, XII, No. 1, January, p. 244.

TYPE LOCALITY.—Lake Superior.

DISTRIBUTION.—Lake Superior; Lake Huron; Lake Michigan; Georgian Bay, Bond Lake (near Toronto), and Ottawa River, Canada; Maine; Rhode Island; Con-

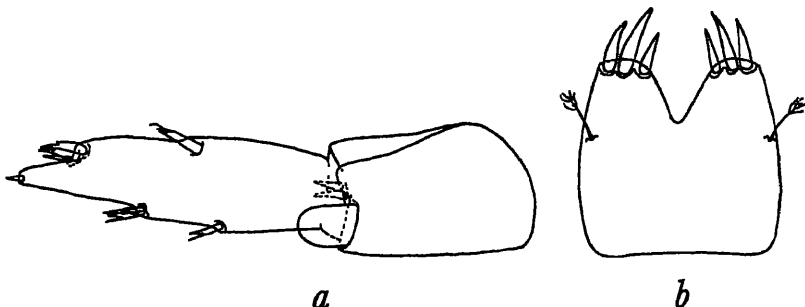


Fig. 9. *Eucrangonyx gracilis* (Smith), specimen from Gainesville, Florida.
a, uropod 3; b, telson.

necticut; New York; Maryland; District of Columbia; Virginia; North Carolina; Florida; Louisiana; Tennessee; Kentucky; Ohio; Indiana; Illinois; Michigan; Wisconsin; Montana; and Missouri.

SPECIMENS COLLECTED.—Seven; Gainesville, Florida, September 29, 1914, A. J. Mutchler.

This is the first record of the occurrence of this species in Florida. Many of the above localities are represented by specimens in the collection of the U. S. National Museum.

Talitridæ

Orchestia platensis Kroyer

Orchestia platensis KRÖYER, 1845, Naturh. Tidsskr., (2) I, p. 304, Pl. II, fig. 2. SCHLLENBERG, 1926, 'Deutsche Südpolar Exped., 1901-1903,' Die Gammariden, p. 371. (Synonymy.)

TYPE LOCALITY.—Banks of Rio de la Plata (northwest of Montevideo).

DISTRIBUTION.—Atlantic coast of North and South America from Bay of Fundy to the Plata River, Argentina; Bermuda; Mediterranean; Lake of Tiberias, Palestine; Belgian Congo; Angola; Low Archipelago; Chilka Lake; Hawaiian Islands; Maldives Islands; Seychelles Islands.

SPECIMENS COLLECTED.—One; Portsmouth, Dominica, West Indies, June 25, 1911, from under small stones and debris on upper beach, Dr. R. W. Miner.

Hyalé brevipes Chevreux

Figures 10, 11

Hyalé brevipes CHEVREUX, 1901, Mem. Soc. Zool. France, XIV, p. 400, Figs. 15-18. WALKER, 1909, Trans. Linn. Soc. Lond., Zool., (2) XII, pt. 4, p. 337. CHILTON, 1921, Ann. Mag. Nat. Hist., (9) VIII, p. 117, text-fig.; 1921, Mem. Ind. Mus., Calcutta, V, No. 8, p. 545, text-figs.; 1925, Mem. Asiatic Soc. Bengal, VI, p. 536. SCHELLENBERG, 1928, Trans. Zool. Soc. Lond., XXII, pt. 5, p. 658.

TYPE LOCALITY.—Seychelles Islands.

DISTRIBUTION.—Schellenberg gives as the distribution: Red Sea; Seychelles, Maldivé Islands; Ceylon; Chulka Lake; and the Talé Sap.

SPECIMENS COLLECTED—Eighty; Fort de France, Martinique, West Indies, April 2, 1910, P. B. Whelpley. Six; Portsmouth, Dominica, West Indies, June 25, 1911, Dr. R. W. Miner, from under small stones and débris on upper beach. Two; Bridgetown, Barbados, West Indies, March 28, 1910, P. B. Whelpley.

These specimens from the West Indies agree with the description given by Schellenberg for his specimens from the Suez Canal (Trans. Zool. Soc. Lond., XXII, pt. 5, p. 659). Gnathopod 1 of the male bears a very conspicuous stout spine-tooth at the center of the palm on the outside, and a smaller submarginal spine on the inside nearer the rounding corner of the palm. These very characteristic spines are neither mentioned by Chevreux in his description nor shown in his figure. The first and second gnathopods of the female appear to be quite variable in structure. In some specimens they closely resemble those of the male, the first bearing the two prominent palmar spine-teeth as in the male, and the second having the sixth joint similar to that of the male except that the palm is not quite so oblique, thus making the posterior margin proportionally somewhat longer. In other females the first gnathopods are as described by Schellenberg, the sixth joint being nearly rectangular, with the palm nearly transverse and lacking the prominent palmar spine-teeth, but having two smaller spines at the defining angle, the posterior margin bearing a row of serrate spines at the center; the second gnathopods having the sixth joint comparatively small, not as wide as the fifth joint, the posterior margin being sinuous and having a rather prominent notch from which protrude several long slender spines, and on the proximal portion a row of short spines.

The largest males measure 9 mm. in length. *Hyalé brevipes* has not heretofore been recorded from the Western Hemisphere.

Hyalella azteca (Saussure)

Amphilos astecus SAUSSURE, 1858, Mem. Soc. Genève, XIV, pt. 1, p. 474, Pl. v, fig. 33

Alorchestes knackerbockeri + *Amphiloë asteca* BATE, 1862, 'Cat. Amphip. Brit. Mus.', p. 36, Pl. vi, fig. 1; p. 250.

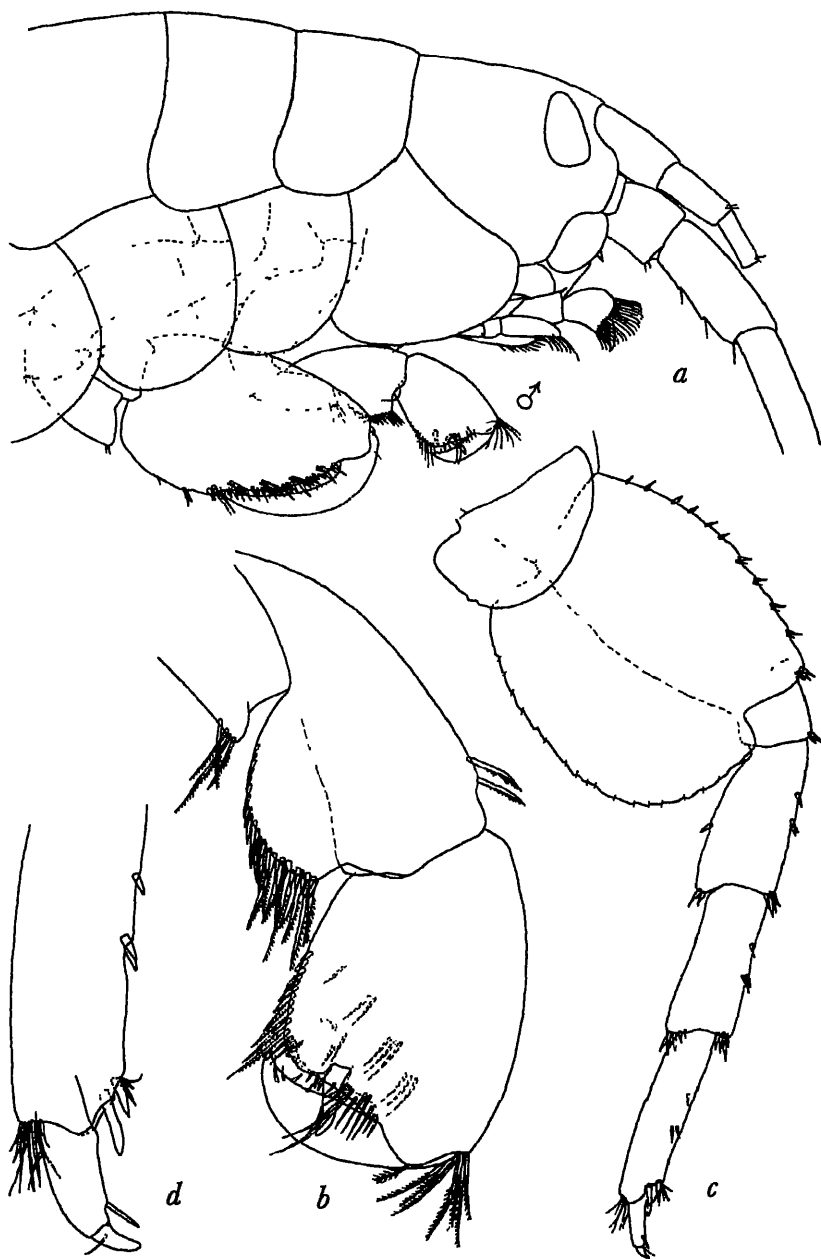


Fig. 10. *Hyale brevipes* Chevreux, male.
 a, anterior end of animal, b, gnathopod 1, c, pereopod 5, d, distal end of pereopod 5, greatly enlarged

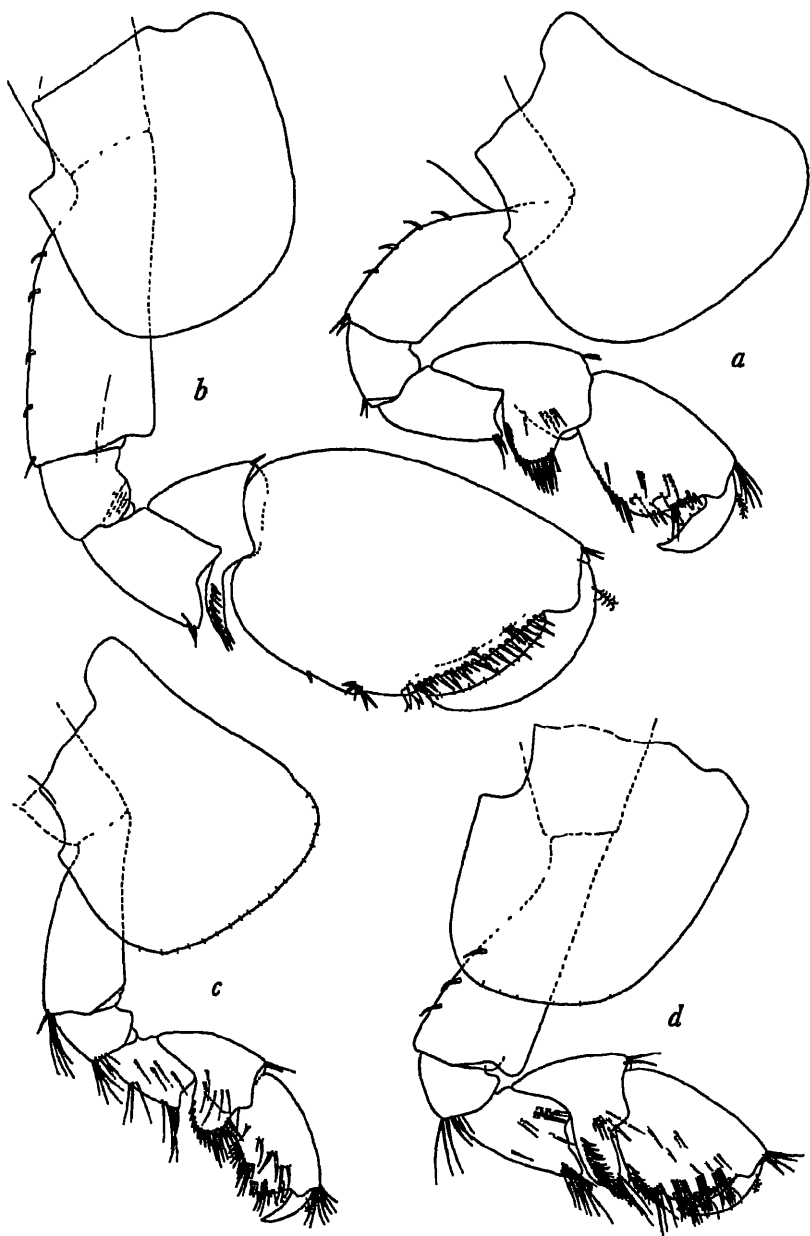


Fig 11. *Hyale brevipes* Chevreux, female.

a, gnathopod 1 of large specimen, b, gnathopod 2 of large specimen, c, gnathopod 1 of smaller specimen, d, gnathopod 2 of smaller specimen.

Hyalella dentata SMITH, 1874, Rep of the U. S. Geol. and Geog. Survey of the Territories, (1873), p. 608, Pl. I, figs. 3-6; 1874, Rep. U. S. Fish Comm., II, p. 646, Pl. II, figs. 8-10. FORBES, 1876, Ill. Museum Nat. Hist., Bull. No. 1, p. 5. RATHBUN, 1905, Occasional Papers, Bost. Soc. Nat. Hist., VII, 'Fauna of New England, V,' p. 53.

Hyalella inermis SMITH, 1874, Rep of the U. S. Geol. and Geog. Survey of the Territories, (1874), p. 609, Pl. I, figs. 1-2.

Allorchestes dentatus FAXON, 1876, Bull. Mus. Harvard, III, p. 373.

Allorchestes dentatus var. *inermis* FAXON, 1876, Bull. Mus. Comp. Zool., III, p. 373.

Lockingtonia fluviatilis HAFORD, 1877, Proc. Calif. Acad., VII, p. 54.

Hyalella azteca STEBBING, 1888, 'Rep. Voy. "Challenger,"' XXIX, p. 311. STOUT, 1912, First Ann. Report, Laguna Marine Lab., Pomona College, p. 149, Fig. 84. PEARSE, 1913, Occasional Papers, Mus. Zool., Univ. Mich., No. 1, p. 3. JOHANSEN, 1925, Canadian Field Nat., XXXIX, No. 6, p. 138.

Hyalella fazoni STEBBING, 1903, Proc. U. S. Nat. Mus., XXVI, p. 928.

Allorchestes dentata PAULMIER, 1905, New York State Mus., Bull. 91, Zool. 12, p. 152, Fig. 19.

Hyalella knickerbockeri WECKEL, 1907, Proc. U. S. Nat. Mus., XXXII, No. 1507, p. 54, Fig. 15. NORTON, 1909, Proc. Portland Soc. Nat. Hist., II, p. 250. WECKEL, 1910, Proc. U. S. Nat. Mus., XXXVIII, p. 623, Fig. 1. JACKSON, 1912, Bull. Wis. Nat. Hist. Soc., X, Nos. 1-2, p. 49. HUNTSMAN, 1914, Contrib. Canadian Biol., 1911-1914, pt. 2, p. 152, Fig. 4d. KUNKEL, 1918, Conn. State Geol. and Nat. Hist. Survey, Bull. 26, p. 129, Fig. 36. SCHULLENBERG, 1931, 'Swedish Antarctic Exped., 1901-1903,' II, No. 6, p. 228, Fig. 116.

Hyalella fazoni + *Hyalella knickerbockeri* PEARSE, 1910, Twelfth Report of Mich. Acad. Sci., p. 73.

Hyalella ornata PEARSE, 1911, Thirteenth Report, Mich. Acad. Sci., p. 109, Fig. 2.

TYPE LOCALITY.—Cistern at Vera Cruz, Mexico.

DISTRIBUTION.—This species inhabits rivers, streams, lakes and stagnant water. It has been recorded from White Horse, Yukon Territory, Alaska; lake forty-eight miles north of Rampart House, Alaska; Hydra Lake, Vancouver Island; Brant's Lake, and Six-mile Lake, Okanagan, British Columbia; Miquelon Lake, Alberta; Last Mt. Lake, Saskatchewan; Oak Lake, Manitoba; Lake Manitoba; near Ottawa, Ontario; Gaspé Peninsula; Charlton Island, James Bay, Hudson Bay; Pembroke Lake, Cape Breton Island; Gamachi Lake and Princeton Lake, Anticosti Island, Province of Quebec; Richibucto, New Brunswick; Grand Lake, Newfoundland; Alexander Bay, Thousand Islands, Lake Superior; Lake Michigan; Lake Ontario; Maine; Massachusetts; Connecticut; New York; New Jersey; Maryland; District of Columbia; Virginia; South Carolina; Florida; Porto Rico; Ohio; Indiana; Illinois; Michigan; Wisconsin; Minnesota, North Dakota; Nebraska; Colorado; Yellowstone National Park; Iowa; Kansas; Arkansas; Montana; Idaho; California; Utah; Nevada; New Mexico; Texas; Ensenada, Lower California; Mexico; Costa Rica; El Salvador; Lake Titicaca, Peru; Montevideo, Uruguay; Patagonia; Punta Arenas, Chile; Tierra del Fuego; and Falkland Islands.

SPECIMENS COLLECTED.—Nine; Titusville, Florida, November 8, 1911, Dr. F. E. Lutz. Fourteen, Laudat, Dominica, West Indies, June 13, 1911, Dr. F. E. Lutz.

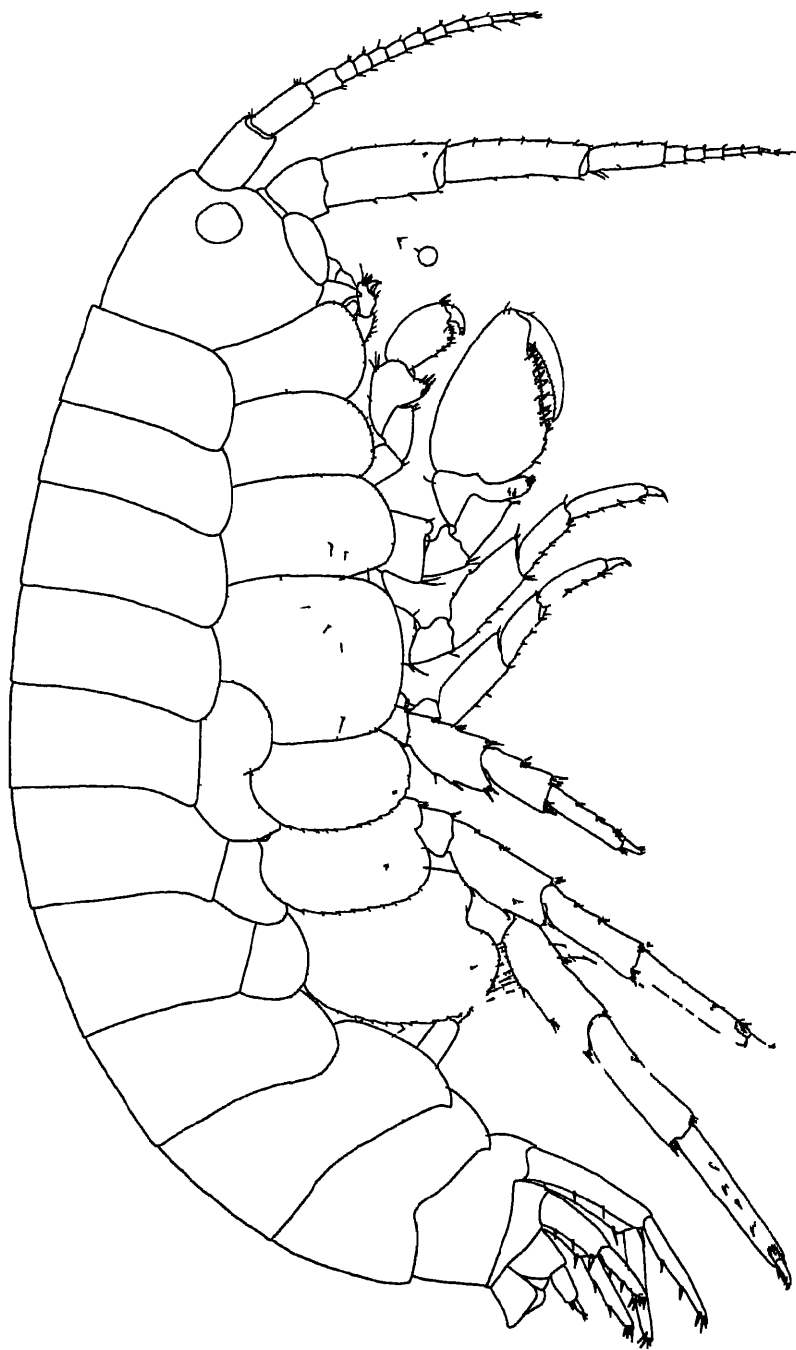


Fig. 12 *Hyalella whepleyni*, new species, male

This is a species of very wide distribution and of considerable variation. It has been reported from Alaska to Tierra del Fuego and from California to Newfoundland and Porto Rico. It is now for the first time reported from Dominica, West Indies. The variation is most noticeable in the number of dorsal teeth. The variety *inermis* is without dorsal teeth, while the number varies from one to four in the dentate form.

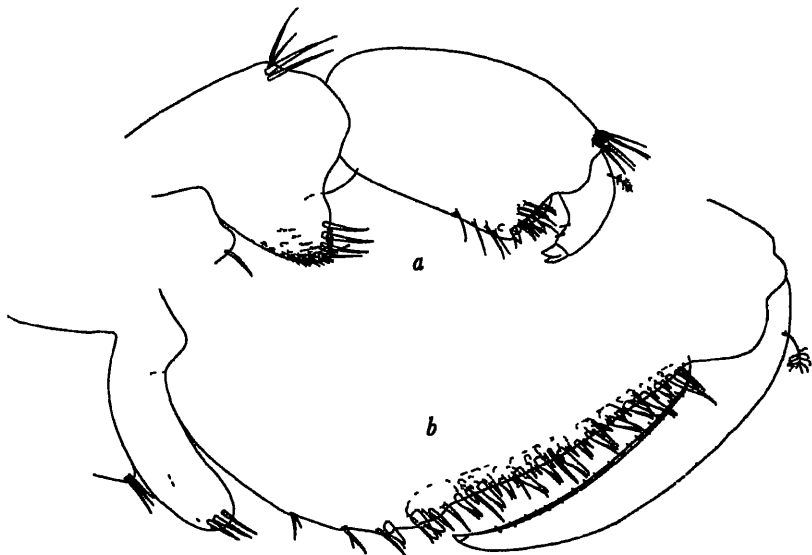


Fig. 13. *Hyalella whelpleyi*, new species, male.
a, gnathopod 1, b, gnathopod 2, greatly enlarged.

***Hyalella whelpleyi*, new species¹**

Figures 12, 13

TYPE LOCALITY.—Port of Spain, Trinidad, British West Indies, January, 1910, P. B. Whelpley. Type in The American Museum of Natural History; Cat. No. 6693.

SPECIMENS COLLECTED.—Seventeen; Port of Spain, Trinidad, British West Indies, January, 1910, P. B. Whelpley.

DESCRIPTION OF MALE.—Head lateral lobe rather shallow, eye small and nearly round. Antenna 1 reaching little beyond peduncle of antenna 2, peduncle shorter than the ten-jointed flagellum. Antenna 2 stout, not half the length of the body, fifth joint of peduncle slightly longer than fourth, flagellum as long as fifth peduncular joint plus about half the length of the fourth, flagellum composed of about ten joints, the first three of which are coalesced. Gland-cone short and inconspicuous. Gnathopod 1: fifth and sixth joints equal in length, fifth with rather narrow hind lobe, sixth

¹Named in honor of Mr. P. B. Whelpley, the collector.

nearly oval in outline, palm slightly oblique, convex, and defined by a rather stout spine and bearing two similar spines on inner surface of joint just below the defining angle, seventh joint very short and stout and armed with a double-toothed apex. Gnathopod 2 stout, second and third joints each with lower front margin produced into a shallow lobe, sixth joint with palm very oblique and about equal in length to hind margin of joint, defined by two short stout spines but with a scarcely perceptible defining angle, seventh joint equal in length to and exactly fitting palm. Peræopod 1 slightly longer than 2. Peræopods 3-5 increasing consecutively in proportions and length. Accessory branchiæ absent. Pleon segments 2 and 3 produced below into very shallow upturned points. Uropod 1 extending farther back than 2 or 3. Uropod 3: peduncle about twice as long as the very short ramus. Telson very prominent and reaching back as far as the proximal end of the peduncle of uropod 3, apex evenly rounding and bearing two minute setules.

LENGTH.—6 mm.

FEMALE.—Antenna 2 shorter and weaker in comparison with antenna 1; flagellum about equal in length to peduncle and composed of nine joints, none of which are coalesced. Gnathopods very similar to those of male but smaller and weaker.

LENGTH.—5 mm.

CYAMIDEA

Cyamidæ

Cyamus species

SPECIMENS COLLECTED.—One; Fort de France, Martinique, West Indies, April 2, 1910, P. B. Whelpley.

This specimen is very young and in very poor condition so that specific identification is not possible.

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NEW DOLICHOPIDÆ FROM NORTH AMERICA WITH NOTES ON SEVERAL DESCRIBED SPECIES

By M. C. VAN DUZEE

Of the twenty-two new species described in this paper, sixteen are from the Nearctic Region and six from Guatemala, the latter taken by Dr. Bequaert. Several interesting species are from Mount Ranier, Washington, some from Electric Lake, Colorado, and Mr. Brown took several of the new species in Quebec.

It has been a great pleasure to me to study this material, and I wish to thank Mr. Curran and Dr. Lutz for sending it to me for determination.

The types of the new species described here are in The American Museum of Natural History, unless otherwise stated in the text.

Condyllostylus aduncus, new species

Length about 4 mm

MALE—Face and front shining green, without pollen or hair; frontal orbits with a row of five long, incurving black bristles; palpi and proboscis black; antennæ black, small, longest bristle on second segment about as long as first two segments of the antenna taken together; third segment scarcely as long as wide, rounded at tip; arista dorsal; beard formed of only a few rather short black hairs.

Thorax shining green with bronze reflections; scutellum and pleura mostly blue; bristles of thorax moderately long; I can see but two marginal bristles on the scutellum. Abdomen shining green with bronze and coppery reflections, the venter black; hair wholly black, the bristles of the abdomen short; hypopygium (Fig. 52) black, its outer claspers long, rather slender, hook-shaped, basal part a little enlarged and with delicate pale hairs.

Coxæ and femora wholly black, except that the front coxæ are green, with a few short black hairs on anterior surface and black bristles near tip; all trochanters black; front tibiae and tarsi dark yellow; middle tibiae brown on basal half, yellowish brown on apical half; hind tibiae wholly black; all femora with long, dark yellow hair below, about as long as width of femora, and with a few black hairs among them; anterior and middle tibiae slender, without bristles, hind tibiae with several bristles, which are so short as to be difficult to separate from the hairs, as they are scarcely longer; all tarsi plain; length of front tibiae as 62, of middle as 92; segments of front tarsi as 40-15-9-6-6; of middle as 59-21-13-8-6; and of posterior pair as 46-18-11-11-7. Calypters, their alia and the halteres black.

Wings grayish, very slightly darker in front; third vein bent backward toward tip; last section of fourth vein bent at a right angle a little before its middle, upper

bend rounded, but almost a right angle, apical part almost straight and ending close to tip of third vein; there is no stump vein at first bend, this part of fourth vein being represented by a slight fold and darkening of the wing membrane; from the cross-vein to fork as 40, from fork to wing margin as 50; last section of fifth vein nearly straight, its length as 38, cross-vein as 31.

Holotype, male, taken in March or April, at Moca, Guatemala, by Dr J. Bequaert

This is a very bright, shining species, almost wholly without pollen; I can see only one pair of bristles on the scutellum, and the fourth vein is formed almost as in *Mesorhaga*, except for the fold in the wing membrane, but it surely should go in *Condyllostylus*. It would run to *erectus* Becker (from Paraguay) in Abbé O. Parent's table of American species (*Annales de la Societe Scientifique de Bruxelles*, XLIX, 1929, p. 7, couplet 26), but that species has the hypopygium almost wholly concealed, the halteres pale yellow, basal half of hind tibiae and whole of middle ones yellow, and middle tibiae with 2-3 bristles

Condyllostylus fusitarsis, new species

Length about 5 mm.

MALE.—Face bare, wide above, but not as wide as front, narrower below the suture, shining green above, below the suture dulled with white pollen, which extends up the sides above the suture; front bright shining green; palpi yellowish brown; antennae wholly black, its three segments of approximately equal length, longest hairs on second segment longer than the antenna, third segment rounded at tip, as long as wide, arista dorsal

Thorax and scutellum green, dorsum shining and with bronze reflections, scutellum with two pair of bristles; abdomen rather dull, reddish coppery; hypopygium small, forming a rounded or flattened and somewhat enlarged tip to the abdomen, its appendages black, very small; the hairs at tip of abdomen rather short

All coxae black, anterior pair with green reflections and yellow tips; all femora blue-green with yellow tips and a few pale hairs below; all tibiae pale yellow, posterior pair slightly brown at tip; front tarsi yellow, becoming brown at tip, middle and hind tarsi wholly black; front tibiae with two slender bristles above, one near basal third and one before apical third; middle tibiae with one bristle above near basal third and three below on basal third, a long, erect spur below at tip and also two small bristles above on apical two-thirds; hind tibiae with one bristle above near basal third and two rows of long bristly hairs below; front basitarsi slender, with short bristles below, which are most numerous near base and about as long as diameter of segment; middle tarsi (Fig 1) with the first segment bearing hooked bristles on lower posterior edge and a row of normal bristles on upper anterior edge; second segment short, bare except at tip; third segment very long and somewhat fusiform, bare; fourth and fifth segments short and thin. Length of front tibiae as 64, of middle pair as 98; segments of front tarsi as 56-16-10-6-6; of middle pair as 49-5-22-6-6; first segment of posterior pair as 45. Calypters brown with black cilia; knobs of halteres yellow, the petiole brown.

Wings grayish, veins brown; costa with rather short hairs; third vein slightly bent backward toward tip; fork of fourth vein at right angles to fourth vein, but arched almost from its base; last section of fifth vein as 21; fourth vein from cross-vein to fork as 35, from fork to wing margin as 32.

Described from one male, taken near New York City. Type in Van Duzee Collection

C. fusitarsis is very much like *cockerelli* Van Duzee, but has the face bare and third segment of middle tarsi of male long, enlarged and bare.

Sciapus divergens, new species

Length, 5-6 mm.

MALE.—Face wide, at top as wide as lower part of front, and half as wide at lower edge, wholly white pollinose; front opaque with grayish white pollen; palpi yellow with white hairs; first two antennal segments pale yellow (Fig. 2), third blackish, narrower than second segment, pointed at tip; arista subapical, nearly bare; beard not very abundant, silvery white below, but mixed with delicate blackish hairs below and at the sides of the neck.

Dorsum of the thorax green, with thick yellowish pollen on front half, which partly conceals the ground color when viewed obliquely; seven pairs of acrostical bristles, the first four very small; scutellum with one pair of large marginal bristles; pleura black, white pruinose, the posterior edge narrowly yellow. Abdomen green with black incisures, dulled with white pollen; posterior margin of first segment a very little yellowish; sides of second and third segments largely yellow, venter yellow; hairs on the dorsum of abdomen black, on lower part of sides white and moderately long; hypopygium (Fig. 3) petiolate, black, its tip and appendages mostly pale yellow, the pair of long, smooth, curved, horn-like claspers (Fig. 4) yellow on basal half, black on apical half, and notched at tip.

All coxae and their hair wholly pale yellow; all femora and tibiae yellow with only short hair, except that the front femora have a few long, delicate, yellow hairs below on basal half, some of these are as long as width of femora; anterior and posterior tibiae each with one small bristle above near basal third; middle tibiae without bristles, long and slender, their length as 107, length of front tibiae as 86; segments of front tarsi as 79-22-22-10 (without projection, over projection as 17), last segment 8; of middle pair as 108-40-29-17-10; of posterior pair as 78-55-33-18-11; front tarsi (Fig. 5) yellow with the projection on fourth segment and whole of fifth black; fourth segment with a diverging projection, which has its apical half slightly enlarged, bare and rounded at tip, thus apical part of the projection appears like a separate segment, fifth segment a little thickened; middle tarsi yellow, a little darkened toward the tip; hind tarsi black from the tip of first segment. Calypters and halteres yellow, tips of former black, their clin white.

Wings grayish, a little narrowed at base, veins brownish black; third vein much bent backward toward tip; fork of fourth vein at a right angle to apical part of fourth vein, which is not quite in a straight line with the rest of fourth vein, the first and second parts of the fork straight; the bend but little rounded; fourth vein from cross-vein to fork as 26, from fork to wing margin, measured in a line with apical part of fourth vein, as 40, but the vein ends at half this distance from the fork; last section

of fifth vein straight, its length as 31; cross-vein very oblique and sinuous, its length as 36; posterior margin of wing with a shallow sinus both before and beyond the tip of fifth vein, thereby forming a slight lobe at tip of both fifth and sixth veins; sixth vein represented by only a fold in the wing membrane; costa not ciliated

Holotype, male, and one paratype, male, taken by R. Latta, June 30, 1931, at Sumner, Pierce Co., Washington

S. divergens is like *pallens* Wiedemann in having the front wholly opaque with pollen, the dorsum of the thorax more or less opaque, first two antennal segments yellow, third brown and the hypopygium of nearly equal size and of the same general form. They differ as follows: *pallens* has third antennal segment rounded, not pointed; the front tarsi in *pallens* have fourth segment white, widened in the middle, somewhat spindle-shaped, fifth segment black, half as long as fourth; it also has long stout bristles below on the front femora of the female and this may separate the female of *divergens* from that of *pallens*, but the female of *divergens* is not known at present.

Among the European species of *Sciapus* are several with the fourth and fifth segments of the anterior tarsi formed about as in this species, the two coming nearest *divergens* are *costæ* Mik and *wiedemanni* Fallen, but in both of these the hypopygium has very different appendages and in the former the front tarsi are wholly black, while in the latter the fourth segment of the anterior tarsi is almost wholly black.

Rhaphium (*Xiphandrium*) *elongatum*, new species

Length, 3 mm

MALE.—Face narrow, its sides nearly parallel, only a little wider above, silvery white; front shining violet; palpi black with black hair; antennæ (Fig. 6) black, second segment with long bristles, one being longer than width of third segment, third segment seven times as long as width at base, tapering rapidly beyond the middle, so as to form a slender tip, distinctly pubescent, arista one and one-fourth times as long as width of third segment at base; upper orbital cilia black, lateral cilia and the long but not very abundant beard silvery white, the hairs forming the beard a little flattened; occiput greenish black with a little whitish pollen

Dorsum of thorax dark shining green; pleura black with green reflections, white pruinose; propleura with a few white hairs above anterior coxæ; abdomen green with bronze reflections, hair on the dorsum black, on the sides more whitish; venter black, white pruinose, with long hair, which is mostly white; hypopygium somewhat round, black, a little metallic, with brown pollen and stiff black hairs; outer lamellæ (Fig. 7) with apical part triangular, black with the hair on convex side largely black, on concave side the hairs are more delicate, curved and whitish, the petiole and its hair yellow; inner appendages (Fig. 8) black with their hair mostly white.

Front coxæ yellow, black at base, with long, silvery-white hair, no black bristles; middle coxæ with yellow tips, a few silvery-white hairs on anterior surface, a silvery-white thorn at tip and two large black bristles on outer anterior surface; hind coxæ

black with yellow tips, a few short white hairs and one black bristle on outer surface; anterior femora yellow below and at base and tip, black above and sometimes on most of posterior surface, their hairs small, few and white on posterior side, middle femora wholly yellow, with black hair; hind femora yellow, black on apical fourth, extending to the middle on upper edge, their hair black, a few white hairs below, especially toward tip; front and middle tibiae yellow, anterior pair with white hair on anterior surface, which extends to tip of tarsi and is scarcely as long as their diameter; front tarsi (Fig. 9) brown from tip of first joint which is a little enlarged at tip, fourth segment shorter than fifth; front tibiae with one small bristle near apical third; middle tibiae with two large bristles beyond basal third and several very small bristles; hind tibiae and tarsi wholly black, their hair partly white, the tibiae with two pairs of bristles above, one pair near the base and one near the middle; middle tarsi brown, a very little yellowish at base; length of front tibiae as 49, of middle 65, and of posterior pair as 90; segments of front tarsi as 23-16-7-4-7; middle pair as 30-15-12-8-7; of hind tarsi as 26-27-20-14-10. Calypters and halteres pale yellow, cilia of former white.

Wings grayish; third and fourth veins somewhat convergent but nearly parallel beyond the bend in the last section of fourth vein, which ends in the apex of the wing; last section of fifth vein straight, its length as 35, cross-vein as 13; posterior margin of wing evenly rounded, but base of wing narrowed.

FEMALE.—Face wide, its suture near the middle, white pollinose; palpi black, covered with white pollen and black hairs; antennae (Fig. 10) black, third segment a little more than twice as long as wide, arista one and one-half times as long as antenna, second antennal segment with rather long bristles; upper edge of front femora blackish, sometimes only slightly so, hind femora with less black at tip than in the male; hind tibiae slightly brown at base and with apical third black, hind tarsi wholly black.

Described from two males and eight females, all taken by W. J. Brown, between June 16-21, 1930, at Thunder River, Quebec.

Rhaphium (*Xiphandrium*) *femoratum*, *pollex*, *dubium* Van Duzee, *exile* Curran, and *elongatum*, new species, form a closely related group, all having the hypopygial lamellae and inner appendages formed very much alike. All have the posterior tibiae and tarsi wholly black or brownish black and middle femora wholly yellow.

The first three have the third antennal segment very obtuse at the tip, tapering but little before near the apex. These are *pollex* (Fig. 15), *femoratum*, and *dubium* (Fig. 11). The other two have the third antennal segment tapering rapidly beyond the middle and the apical portion slender, almost acutely pointed at the tip. These are *exile* (Fig. 12) and *elongatum* (Fig. 6), which also have the bristles on second segment decidedly longer than in the first three species.

Of the first three, *femoratum* has the first and second segments of the hind tarsi as 21-14 and the segments of the front tarsi as 23-12-8-6-7, *pollex* has the segments of front tarsi as 23-11-7-4-6 and of hind tarsi as 24-26-19-12-10; and *dubium* has the segments of hind tarsi as

20-24-15-10-10. Of the last two species, *exile* has the hypopygial lamellæ (Fig. 13) long and rather slender, with a very long curved hair at the tip, and the front tarsi (Fig. 14) have their segments as 23-13-6-5-4, while in *elongatum* segments of front tarsi are as 23-11-7-4-7.

The following table will help to separate these species.

- | | |
|---|---------------------------------|
| 1—Third antennal segment slender toward the tip; bristles on second antennal segment long | 2. |
| Third antennal segment wide almost to its tip; bristles on second antennal segment shorter. | 3. |
| 2—Hypopygial lamellæ with a long hair at tip; fifth segment of front tarsi shorter than fourth | <i>exile</i> Curran. |
| Lamellæ shorter and without a conspicuously long hair at tip, fifth segment of front tarsi longer than fourth | <i>elongatum</i> , new species. |
| 3—Second segment of hind tarsi two-thirds as long as first | <i>femoratum</i> Van Duzee. |
| Second segment of hind tarsi longer than first | 4. |
| 4—Widest part of third antennal segment near the base; second segment of hind tarsi one-fourth longer than first; front femora wholly yellow. | <i>dubium</i> Van Duzee. |
| Widest part of third antennal segment beyond the middle; second segment of hind tarsi one-twelfth longer than first; front femora mostly black. | <i>pollex</i> Van Duzee |

Rhaphium (*Xiphandrium*) *femineum* has the hypopygial lamellæ small, somewhat oval, and would not go in this group at all, as I look at it now.

***Rhaphium* (*Porphyrops*) *hirtimanus*, new species**

Length, 4 mm.

MALE.—Face in the middle half as wide as width of third antennal segment, a little wider above, silvery white; palpi black with a little white pollen at tip, a few black hairs and one yellow bristle; front nearly opaque with dark gray pollen, a little longer than wide; antennæ (Fig. 16) black, one and one-half times as long as wide, rather rounded at tip, arista slender, one and one-half times as long as antennæ, upper orbital cilia black, beard silvery white, long and abundant.

Dorsum of thorax bronze-green with a bronze-brown stripe on each side of the acrostical bristles; pleura black with a slight green tinge and white pollen. Abdomen green with bronze reflections, hairs on first segment and on the sides yellow, on the dorsum black, hairs on the sides at base of abdomen long. Hypopygium (Fig. 17) black, its outer lamellæ very long, black, narrow and tapering to their tips, with long, delicate, pale, curved hairs on each edge of inner side (in the drawing they show as one row, being all turned inward), inner appendages nearly bare, enlarged and yellowish at tip.

All coxæ colored like the pleura and with silvery-white hair, that on anterior pair long and abundant, posterior coxæ with only a few small white hairs, no black bristle; front trochanters brownish yellow, middle and hind trochanters, narrow tips of femora, extreme base of hind femora and front and middle tibiae yellow; hind tibiae yellow at base, shading into brown, with apical fourth black above, below the black

extends nearly to the middle; anterior femora with black hair, the lower surface nearly bare; middle and hind femora with a few rather short, delicate, white hairs below; front tibiae with two bristles on upper posterior edge of basal half, and on anterior surface are three bristles on basal half and one near tip, none below; middle tibiae with eight bristles on upper surface and a pair below near apical third; hind tibiae with three bristles on upper posterior and two on upper anterior surface of basal two-thirds, also two on lower posterior surface; anterior tibiae and tarsi with their hair stiff, bristly and abundant, but not very long; front tarsi yellow with most of last two segments brownish black; middle tarsi infuscated from tip of first segment; hind tarsi wholly black; all tarsi plain. Length of front tibiae as 70, middle tibiae as 89, and posterior pair as 118; segments of front tarsi as 32-13-10-6-7; of middle ones as 41-18-15-11-8; of posterior pair as 38-35-23-15-12. Calypters and halteres pale yellow, cilia of the former white.

Wings uniformly tinged with brown; posterior margin evenly rounded; apex of wing between tips of third and fourth veins; last section of fifth vein as 38, cross-vein as 20; third and fourth veins bent about as usual in this genus.

FEMALE.—Face very wide with yellowish pollen, especially on lower portion; palpi velvety black with white pollen on their edges, front green or bronze color with brownish-gray pollen; third antennal joint about as long as wide, somewhat triangular; thorax with the same two bronze-brown stripes as in the male; abdomen depressed, green, its hair mostly black, the white hair on the sides at base much shorter than in the male, in the allotype the abdomen is coppery black; front and middle trochanters yellowish brown, posterior ones yellow; hair on anterior coxae moderately long, white or yellowish white; all tibiae yellow, posterior ones a little brown at tip; hind femora more broadly yellow at base than in the male; all tarsi brown or black almost to their base, which is more or less yellowish; last section of fifth vein as 65, cross-vein as 20; wings colored as in the male.

Described from one male and two females. Holotype and allotype taken May 9, 1931, at Rock Creek, Alsea Mount, Oregon, by J. Wilcox; paratype, female, taken July 29, 1930, at Portland, Oregon, by R. E. Dimock.

Rhaphum hirtimanus is very much like *nigrovittatum* Curran, but that species has long white hair on posterior and lower surface of anterior femora, while in *hirtimanus* the hair on the front femora is wholly black or nearly so, although there may be a few small white hairs on upper posterior surface, though I am not sure about these, as in most lights they appear wholly black. The paratype is in poor condition, but seems to be the same species, the female would run in the Curran table of species, Transactions of the Royal Canadian Institute, Toronto, XV, part 2, page 258, couplet 13 to *nigrociliatum* Curran, but that species has the tibiae reddish with black base, while in *hirtimanus*, all the tibiae are yellow at the base.

Dolichopus bryanti Van Duzee

One pair of this species was taken by W. J. Brown, August 6, 1929, at Natashquan, Quebec. The following are a few additions and correc-

- Fig 1 *Condylostylus fusitarsis*, new species Middle tarsus of male
- " 2 *Sciapus divergens*, new species Antenna of male
- " 3. *Sciapus divergens*, new species Hypopygium of male
- " 4 *Sciapus divergens*, new species Hypopygial claspers of male.
- " 5. *Sciapus divergens*, new species Front tarsus of male
- " 6 *Rhaphium elongatum*, new species Antenna of male
- " 7. *Rhaphium elongatum*, new species Outer hypopygial lamella of male.
- " 8. *Rhaphium elongatum*, new species Inner hypopygial appendages of male
- " 9 *Rhaphium elongatum*, new species Front tarsus of male.
- " 10 *Rhaphium elongatum*, new species Antenna of female
- " 11 *Rhaphium dubium* Van Duzee Antenna of male
- " 12 *Rhaphium exile* Curran. Antenna of male
- " 13 *Rhaphium exile* Curran Hypopygial lamella of male
- " 14 *Rhaphium exile* Curran Front tarsus of male.
- " 15 *Rhaphium pollex* Van Duzee. Antenna of male
- " 16 *Rhaphium hirtimanus*, new species Antenna of male.
- " 17 *Rhaphium hirtimanus*, new species Hypopygium of male
- " 18 *Dolichopus bryanti* Van Duzee. Hypopygial lamella of male.
- " 19 *Dolichopus breviculatus*, new species Hypopygial lamella of male.
- " 20 *Dolichopus brunefacies*, new species Hypopygial lamella of male.
- " 21 *Dolichopus fallax*, new species Antenna of male
- " 22 *Dolichopus fallax*, new species. Hypopygial lamella of male.
- " 23 *Dolichopus fallax*, new species Tip of wing of male.
- " 24 *Dolichopus flavifacies*, new species Antenna of male.
- " 25. *Dolichopus flavifacies*, new species. Front tarsus of male
- " 26 *Dolichopus parvimanus*, new species Antenna of male.
- " 27 *Dolichopus parvimanus*, new species. Hypopygial lamella of male.
- " 28. *Dolichopus parvimanus*, new species. Front tarsus of male
- " 29. *Hercostomus ornaticauda*, new species Antenna of male.
- " 30 *Hercostomus ornaticauda*, new species Hypopygium, not showing the elbowed bristles
- " 31. *Hercostomus ornaticauda*, new species. Hypopygium, showing the elbowed bristles.

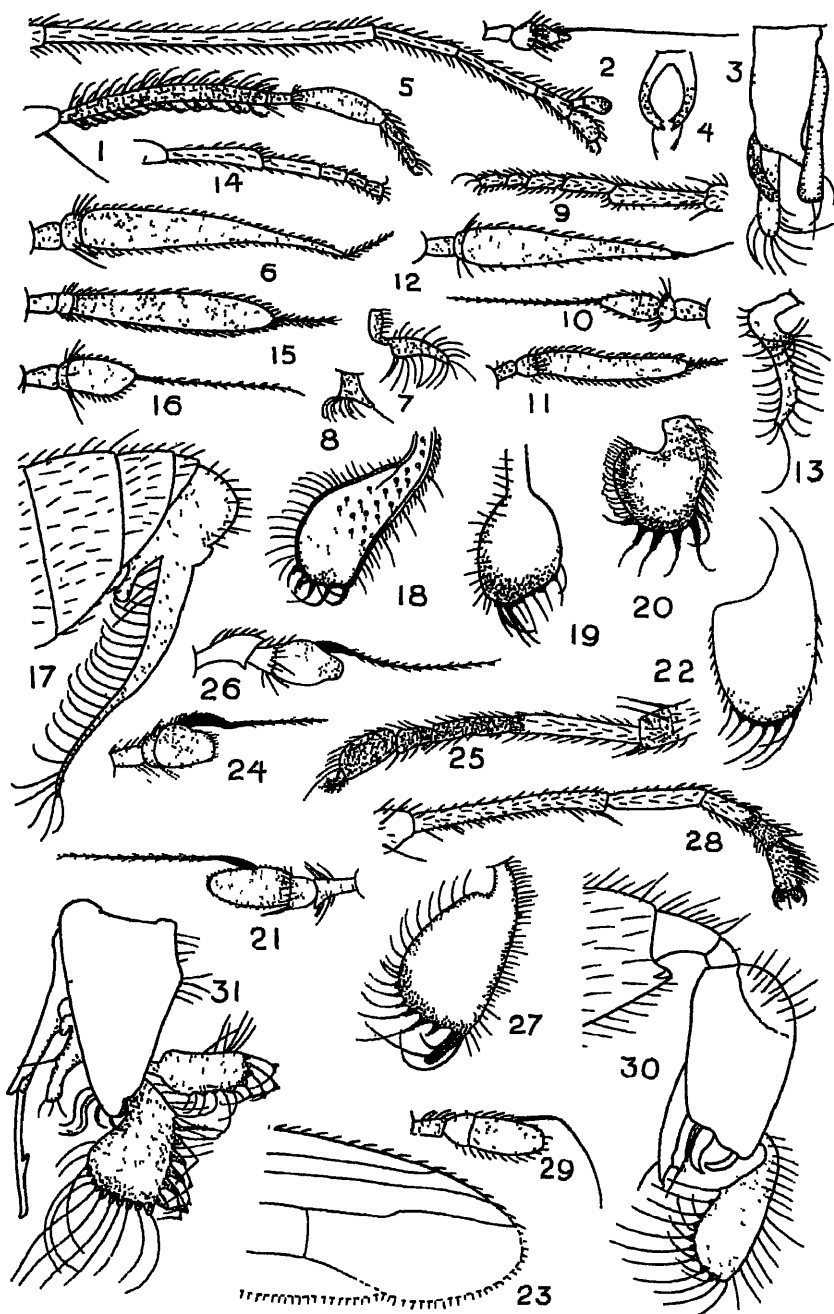


Fig. 32. *Gymnopternus convergens* Van Duzee. Hypopygial lamella, not showing the elbowed bristles.

" 33. *Gymnopternus convergens* Van Duzee. Hypopygial lamella, showing the elbowed bristles.

" 34. *Gymnopternus brevipes*, new species. Antenna of male.

" 35. *Gymnopternus brevipes*, new species. Hypopygium of male.

" 36. *Gymnopternus browni*, new species. Antenna of male.

" 37. *Gymnopternus browni*, new species. Hypopygial lamella of male.

" 38. *Gymnopternus nigrifacies*, new species. Antenna of male.

" 39. *Gymnopternus nigrifacies*, new species. Hypopygium of male.

" 40. *Parachus coxalis*, new species. Antenna of male.

" 41. *Parachus coxalis*, new species. Hypopygium of male.

" 42. *Parachus coxalis*, new species. Hypopygial lamella of male.

" 43. *Parachus fraternus*, new species. Antenna of male.

" 44. *Parachus fraternus*, new species. Hypopygial lamellæ of male.

" 45. *Parachus sordidus*, new species. Antenna of male.

" 46. *Parachus sordidus*, new species. Hypopygium of male.

" 47. *Parachus angusticauda*, new species. Antenna of male.

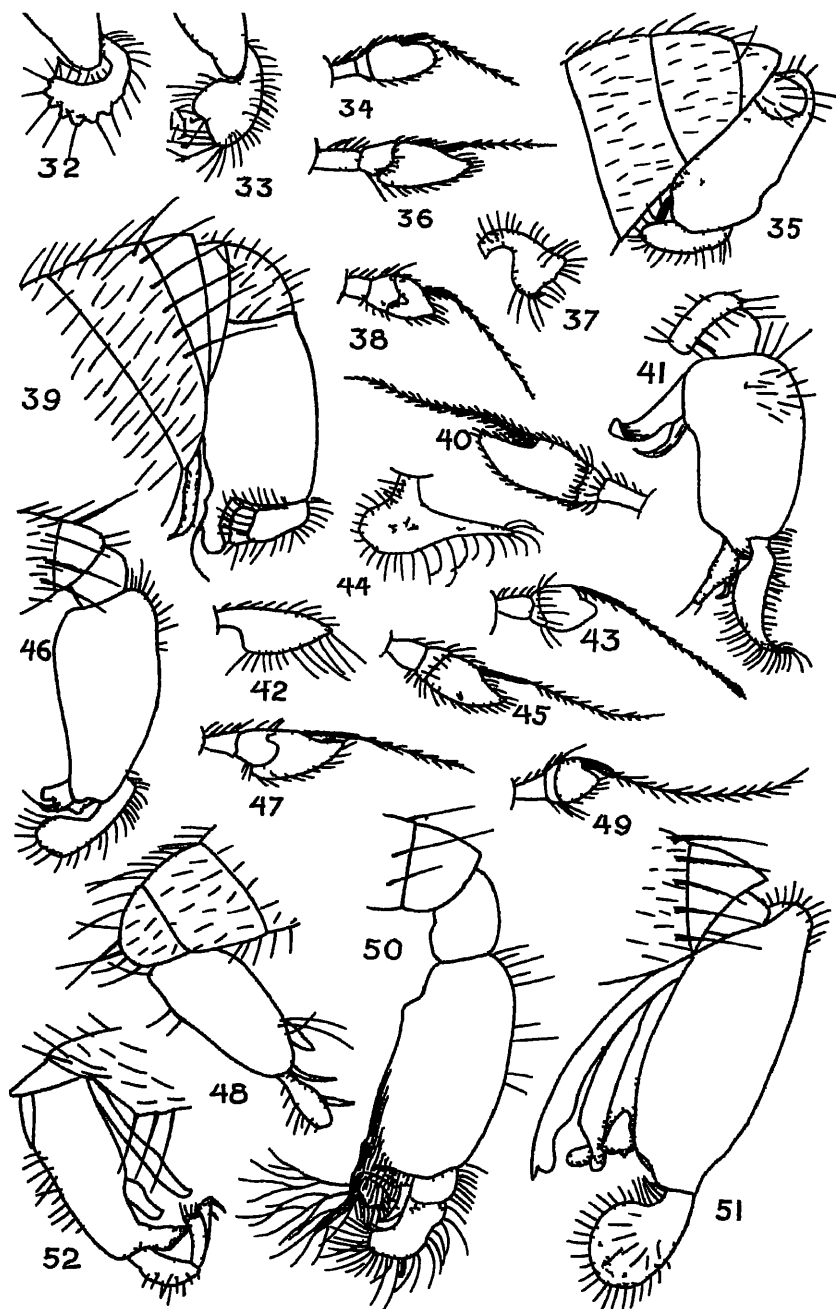
" 48. *Parachus angusticauda*, new species. Hypopygium of male.

" 49. *Sarcionus obtusus*, new species. Antenna of male.

" 50. *Pelastoneurus abbreviatus* Loew. Hypopygium of male.

" 51. *Pelastoneurus bequaerti*, new species. Hypopygium of male.

" 52. *Condyllostylus aduncus*, new species. Hypopygium of male.



tions to the description given in Bulletin 116, U. S. National Museum, 1921, page 104, Fig. 61.

Length, 3.5 to 4.2 mm. Palpi and proboscis blackish brown; antennæ wholly black, third segment about one and one-third times as long as wide, rounded at tip; hypopygium and its lamellæ moderately large, the lamellæ (Fig. 18) whitish with a very narrow black border which toward basal half becomes more yellowish and seems thickened; the lamellæ are nearly two-thirds longer than wide and are jagged and bristly on apical margin, on apical part of inner surface they have quite long hair on the disk, on the outer surface toward the base are minute circles of brown from which minute hairs arise; in this male the black of the posterior legs is not quite as extensive as in the paratype I have. In the paratype the black extends narrowly along the upper edge of the hind femora nearly to their base and the hind tibiæ are black almost to their base, only a little yellowish at the knees, while in the male before me the yellow on the hind tibiæ extends to the basal third on the upper edge, and the upper edge of the femora is scarcely at all darkened, except at the tip. The wings have the costa a little enlarged at tip of first vein, gradually tapering to normal as in the drawing in the Bulletin (Fig. 61). In the description in the Bulletin it says "costa with a small knot-like enlargement at tip of first vein," but I do not think this would show as a knot, unless viewed from above.

The anterior tarsi are one and one-fifth times as long as their tibiæ, middle and hind tarsi two-fifths longer than their tibiæ; segments of anterior tarsi as 30-15-10-7-9; of middle ones 48-28-18-11-9, of posterior pair as 42-39-27-16-12.

Dolichopus ornatipennis Van Duzee

Two males and one female of this species were taken by C. H. Curran, July 10, 1930, at Oakdale, Long Island, N. Y. The male was described from Massachusetts, in Bulletin 116, U. S. National Museum, page 132, Plate vi, figs 87 and 87a.

The female has the wing as in the male; middle tibia with a pair of bristles below at apical third, a single one near the middle and another near basal third; hind tibiæ with a row of hairs below, which are stiff and of increasing length, ending in a large bristle near apical fifth; face, front, antennæ, legs, tarsi and front coxæ colored about as in the male; bristle on upper surface of middle basitarsi a little smaller than in the male.

Dolichopus humilis Van Duzee

Bulletin 116, U. S. National Museum, page 108, Plate v, figs 64 and 64a.

Described from a single male, taken in Alaska.

I received from the American Museum one male and four females of this species, all taken somewhere in Greenland. All have the front shining, dark blue, almost blue-black.

FEMALE.—Second and third antennal segments taken together scarcely as long as first and nearly round in outline, but third a little pointed at tip; face wide, black, covered with thick gray pollen; palpi dark yellowish; lateral and inferior orbital cilia

yellowish, cilia of calypters yellow; anterior femora black, rather widely yellow at tip; middle femora wholly yellow, or with a blackish streak below on basal half; hind femora more or less black on basal half, remainder yellowish; hind tibiae black at tip, with two bristles below, which are placed quite close together; middle tibiae with one bristle below, their basitarsi without a bristle above; front and middle tarsi black from the tip of the first segment, hind tarsi wholly black; anterior tarsi only a little longer than their tibiae, middle tarsi distinctly longer than tibia; wings about as in the male, except that the costa is only a very little enlarged at tip of first vein, tapering to its tip

***Dolichopus breviciliatus*, new species**

Length, 4 mm.

MALE—Face narrow, dark yellow; front dark shining blue; palpi yellow, proboscis black; antennae wholly black, third segment a little longer than wide, somewhat conical in outline; lower orbital cilia white

Thorax and abdomen shining green with blue and bronze reflections; pleura and sides of abdomen with a little white pollen; hairs and bristles of abdomen black; hypopygium black, its lamellae (Fig. 19) white with a black border at tip, the hairs on their edge black, a few white hairs on the surface near upper edge and on the petiole, jagged and bristly on the upper apical corner

Anterior coxae yellow, blackish at base on outer surface and with numerous small black hairs on anterior surface and four large black bristles near tip; middle and hind coxae black; trochanters, femora and tibiae yellow; apical fifth of hind tibiae sharply black; middle and hind femora each with one preapical bristle, the latter ciliated on lower posterior edge with pale yellow hairs, which are about three-fourths as long as width of femora; front tibiae with a row of very short bristles on upper surface, and three somewhat longer ones, also two small bristles on lower posterior edge, the larger one near basal third and a small one near apical third; middle and hind tibiae with large bristles above, the former with one large bristle near apical third of lower posterior surface, hind tibiae with a row of small bristly hairs below on apical half; all tarsi plain; anterior and middle tarsi black from the tip of the first segment; hind tarsi wholly black; front tibiae as 72, middle 104, and hind 105; segments of anterior tarsi as 41-19-15-10-9; middle pair as 51-25-21-13-10, posterior pair as 50-45-30-20-13 Calypters and halteres yellow, the cilia of the former black

Wings grayish, costa with a small, knot-like enlargement at tip of first vein; last section of fourth vein a little bent before its middle, third vein a little bent backward at tip; last section of fifth vein straight, its length to wing margin as 35, cross-vein as 23; anal angle of wing rather prominent, the wing being of nearly equal width throughout; hind margin of wing a little notched at tip of fifth vein, which scarcely reaches the margin

TYPE—Male, taken by W. J. Brown, August 1, 1929, at Natashquan, Quebec; in Canadian National Collection

This is almost like *setosus* Loew, but is smaller and differs in having the face yellow, almost ocher-yellow, the antennae wholly black and the cilia of the hind femora less than half as long as in that species.

***Dolichopus bruneifacies*, new species**

Length, 4 mm.

MALE.—Face moderately wide, brown, but not dark, seen from above yellowish brown; palpi and proboscis black; front shining green; antennæ wholly black, the third segment a little longer than wide, obtuse at tip; lower orbital cilia yellowish white; the black cilia do not extend down to the middle of the eyes.

Thorax and abdomen very dark shining green; dorsum of thorax with brown pollen, which is visible when viewed obliquely; hairs of abdomen black; hypopygium black, its lamellæ (Fig. 20) whitish, tinged with brown and with a black border, jagged and bristly on upper apical corner; inner appendages yellowish brown.

Coxæ, trochanters, femora, tibiæ and tarsi wholly black, even the knees are not yellow; anterior coxæ with short black hair; hind femora ciliated with a few dark yellowish hairs on apical half of lower surface; hind tibiæ thickened throughout, shining; middle basitarsi without a bristle, but with a few little spines below; middle tarsi one-fourth longer than their tibia; anterior tibiæ four-fifths longer than basitarsi; segments of middle tarsi as 58-28-22-13-8. Calypters and knobs of halteres dark yellow, cilia of former white.

Wings grayish; costa with a short, very slight enlargement at tip of first vein; last section of fourth vein bent at its middle; last section of fifth vein twice as long as the cross-vein.

FEMALE.—Face wide, dark grayish pollinose; third antennal segment about as long as wide; palpi black, proboscis brown; otherwise colored about as in the male; form of wing about as in the male, except that there is no enlargement of the costa.

Described from six males and three females, taken June 28, 1919, at Electric Lake, La Plata County, Colorado, at an elevation of 8400 feet, by Dr. F. E. Lutz.

This species is near *interjecta* Van Duzee, but in that species the hind femora are without cilia below; the hind tibiæ are scarcely thickened, except toward the tip, the knees and front and middle trochanters are yellow, the middle tarsi about as long as their tibiæ and the face is silvery white.

***Dolichopus fallax*, new species**

Length, 4.5 mm; of wing, 4 mm.

MALE.—Face, palpi and proboscis dull black, face wide above, a little narrowed below; front shining green with bronze reflections; antennæ (Fig. 21) black, third segment about twice as long as wide, bare, rounded at tip, arista inserted near middle of upper edge, its pubescence very short; a few of the lower orbital cilia whitish.

Thorax and abdomen coppery and green, in the holotype mostly coppery; hairs of the abdomen black, those on lower part of sides short and whitish; venter almost bare; hypopygium black, its lamellæ (Fig. 22) sordid whitish with a narrow, black, apical border, jagged and bristly on outer margin.

Coxæ, femora, tibiæ, and tarsi wholly black; front coxæ with short black hair, among which there seem to be a few delicate white hairs; all femora with only very short hair below; middle and hind femora each with two preapical bristles, one in front of the other; anterior tibiæ with three large bristles on middle half above and two below; middle tibiæ with three conspicuously long bristles near apical third, two

above and one below, those at tip also long, while on upper surface are two shorter bristles near the base and one near the middle; hind tibiae with seven large bristles above, none below; front tarsi one and one-half times as long as their tibiae; segments of anterior tarsi as 39-17-14-9-10; of middle pair 39-20-15-10-10; those of posterior pair 52-50-37-23-15. Calypters and halteres yellow, former with long, stout, black cilia and some delicate, pale yellow hairs.

Wings (Fig. 23) gray with brown veins and yellow root; third vein a little bent backward at tip, last section of fourth vein quite sharply bent near its middle; last section of fifth vein as 45, cross-vein as 25; a slight enlargement of the costa at tip of first vein.

FEMALE.—Like the male in general characters and color; face wider with parallel sides and covered with a little dark gray pollen; third antennal segment a little longer than wide; front tibiae without bristles above, but with a small one below; middle tibiae with four large bristles on middle half above and one below near apical third; posterior tibiae with about ten bristles above and a row of very short, hairlike spines on lower anterior surface; wings tinged with brown in front as far back as third vein.

Described from two pairs, all taken at Electra Lake, Colorado, between June 28 and July 1, 1919, by F. E. Lutz, at about 8400 feet elevation.

This male is much like *nugrmanus* Van Duzee, but in that species the middle and hind femora have only one preapical bristle, the face is silvery white and the costa much enlarged. The female would run to *adequatus* Van Duzee, but in *adequatus* the front tarsi are scarcely as long as their tibiae, and the face silvery white.

Dolichopus flavifacies, new species

Length, 4 mm.

MALE.—Face rather pale yellow, moderately narrow in the middle; front shining green; palpi brownish yellow with black hairs; proboscis black; antennae (Fig. 24) moderately large, black, rounded at tip; arista dorsal, one-third longer than the antenna; orbital cilia wholly black.

Dorsum of thorax shining green with a little white pollen along the front; scutellum more coppery. Abdomen shining green, its incisures narrowly bronze or coppery; hypopygium black, its lamellae rather large, formed about as in *stenhammari* Zetterstedt (Plate II, fig. 22a, U. S. National Museum, Bulletin 116); black, a little yellowish brown in the middle.

Front coxae dark yellow, blackened on outer surface nearly to their middle, their hair black; middle and hind coxae black; all femora and tibiae yellow; tips of hind femora and apical fifth of their tibiae black; all femora nearly bare below; middle femora with two preapical bristles, placed longitudinally; hind femora with one preapical bristle; fore tibiae with four bristles above, one of which is small, and two long slender bristles below; middle tibiae without a bristle below and middle basitarsi without a bristle above; anterior and middle tarsi black from tip of first segment, the hind tarsi wholly black; front tarsi (Fig. 25) with third and fourth segments a little, the fifth considerably widened; middle and hind tarsi plain; front tibiae as 75, segments of front tarsi as 35-10-9-8-13; of middle pair as 59-26-20-16-14; of posterior pair as 53-47-35-24-15. Calypters and halteres yellow, cilia of former black.

Wings a little grayish; costa with a small knotlike enlargement at tip of first vein; last section of fourth vein moderately bent just before its middle and about opposite tip of fifth vein, which is not quite twice as long as the cross-vein, anal angle of wing prominent, almost forming a lobe at tip of sixth vein, although the wing is somewhat narrowed toward the base.

TYPE—Male, taken by W. J. Brown, July 3, 1929, at Harrington Harbor, Quebec; in Canadian National Collection.

This would run to *dasyops* Malloch, in the table of species in Bulletin 116, U. S. National Museum, page 14, but it differs greatly from that species. *D. dasyops* has the hypopygial lamellæ mostly white; the hind femora wholly yellow, the last segment of the anterior tarsi very broad and the costa not enlarged at the tip of the first vein.

Dolichopus parvimanus, new species

Length, 5 mm.

MALE.—Face wide, a little narrowed below, brownish yellow; front dull greenish; antennæ (Fig. 26) yellow with tip of third segment brown; the orbital cilia are almost all gone in the type, but I see no black ones below the middle, although there seem to be one or two whitish ones near the proboscis.

Thorax and abdomen green with coppery reflections; dorsum of thorax dulled with yellowish-brown pollen; hypopygium black, its lamellæ (Fig. 27) quite large, white with a narrow black apical border, which is jagged and bristly.

Anterior coxæ wholly yellow with a few small black hairs and a row of five bristles of decreasing size at tip; middle and hind coxæ black, broadly yellow at tip; femora and tibiae yellow, apical tenth of posterior tibiae black; anterior and posterior femora and tibiae without bristles or long hair below (middle legs missing in type); anterior tibiae with two long bristles and several smaller ones on upper anterior edge; posterior tibiae with strong bristles above; hind femora with one preapical bristle; front tarsi (Fig. 28) yellow with last two segments black, the fifth with long dense black hair above; hind tarsi wholly black; front tarsi one and one-half times as long as their tibia, their segments as 47-21-17-7-15. Calypters and halteres yellow, the cilia of the former black.

Wings grayish, a little darker in front; costa not enlarged at tip of first vein; third vein bent backward a little at tip.

Described from one male, taken by Dr. F. E. Lutz, June 7, 1919, at Regnier, Colorado, at about 4500 feet elevation.

This species is something like *vigilans* Aldrich, but that species has the face silvery white, the front violet and the third antennal segment smaller.

Hercostomus ornaticauda, new species

Length, 3 mm.

MALE.—Face narrow, grayish-white pollinose, its sides parallel; front dark green or bronze-green, gray pollinose; palpi black; antennæ (Fig. 29) black, third segment twice as long as wide, rounded at tip; orbital cilia wholly black.

Dorsum of thorax and abdomen dark shining green; abdomen with black hair

and slight bronze reflections; pleura blackish; hypopygium (Fig. 30) black, pedunculated with black lamellæ, which are somewhat oval but taper into a rather slender petiole, they are fringed on outer edge with moderately long hairs, on apical part with very long, fine hairs (see Fig. 30), and on the inner surface near the edge with elbowed bristles which have a small projection at the elbow (see Fig. 31); this last figure also shows three pairs of inner appendages, one pair of plain hooks, one pair of bent spines and one of clubbed, the long central organ and its sheath, which is short.

Legs wholly black; anterior coxæ with small black hairs; anterior tibiæ with two pairs of small bristles above, none below; middle tibiæ with three pairs of long bristles above and one bristle on upper posterior surface near basal third, none below; posterior pair with four pairs of bristles above and one smaller one below near apical third; front and middle femora with short hair below; posterior femora with a row of hairs on lower anterior surface, which are moderately long; middle and hind femora each with one preapical bristle; all tarsi plain, except first segment of posterior pair, which has a bristle at the tip; length of front tibiæ as 52; middle as 68 and posterior as 66; segments of front tarsi as 21-11-8-5-3; of middle pair as 32-16-12-7-7; and of posterior pair as 25-23-15-11-11. Calypters and halteres yellow, the cilia of the former black.

Wings slightly tinged with brown; third vein bent backward toward its tip; last section of fourth vein nearly straight, making it somewhat convergent with third, ending a little in front of apex of wing, last section of fifth vein as 31, cross-vein as 14; posterior margin of wing evenly rounded, the anal angle being somewhat narrowed.

FEMALE.—Nearly like the male; face a little wider and the third antennal segment about as long as wide.

TYPES.—Described from five males and six females; holotype, male, and allotype, female, and five paratypes, taken by J. Wilcox, August 13, 1931, at Sunrise, Mt. Rainier, Washington, at an elevation of 6318 feet, and one pair taken by H. A. Scullen, August 1, 1930, at Crater Lake, South Rim, Oregon, at 7100 feet elevation.

Hercostomus ornaticauda is very much like *H. (Gymnopternus) convergens* Van Duzee, but both male and female of *convergens* have two preapical bristles on the middle and hind femora and the hypopygial lamellæ are of different form (see Figs. 32 and 33).

Hercostomus (Gymnopternus) brevipes, new species

Length, 2.4 mm

MALE.—Face about one-third as wide as the head, twice as long as wide, silvery white, its suture near the lower edge, making the lower part twice as wide as long; proboscis and palpi black; antennæ (Fig. 34) black, third segment rounded at tip, one and one-half times as long as wide; front black with dark gray pollen; the orbital cilia seem to be wholly black.

Dorsum of thorax and the abdomen shining metallic black with slight purple reflections; dorsum of thorax with a very little brown pollen; pleura dull black; acrostical bristles represented by two large bristles on anterior part; hairs on sides of abdomen appear whitish, those on the dorsum are more black; hypopygium (Fig. 35) black, rather small, its lamellæ somewhat crescent-shaped, fringed with fine hairs.

Coxæ, femora, tibiæ, and tarsi black, the front tibiæ somewhat yellowish with two pairs of bristles above and none below; front coxæ with a few very small black

hairs; hind tibiae with a pair of bristles below near the middle; length of front tibiae as 36; segments of front tarsi as 15-6-5-5-5; of middle tarsi as 24-10-7-5-9; of posterior pair as 17-19-13-8-9. Calypters brown with black cilia; halteres black.

Wings dark gray, tinged with brown as far back as fourth vein; third and fourth veins nearly parallel beyond the cross-vein, the fourth ending in the apex of the wing; last section of fifth vein curved, its length as 26, cross-vein as 11; anal angle of wing quite prominent

Described from one male, taken by G. Hendrickson, June 5, 1927, at Ames City, Iowa.

H. brevipes is something like *tibialis* Van Duzee, but it is smaller, has the third antennal segment one-half longer than wide and rounded at the tip; the middle and hind tibiae wholly black; the wings darker in color and the last section of the fifth vein two and one-half times as long as the cross-vein. *H. tibialis* has the last section of the fifth vein a little over one and three-fourths times as long as the cross-vein, the middle tibiae yellowish, the third antennal segment about as long as wide and somewhat pointed at tip, and is 3 to 3.2 mm. long.

***Hercostomus (Gymnopternus) browni*, new species**

Length, 2.3-3 mm.

MALE.—Face and front dull black, with slight traces of gray pollen on lower part; palpi velvety black; antennae (Fig. 36) wholly black, third segment twice as long as wide, pointed at tip, with long pubescence; occiput very dark green with thin gray pollen; orbital cilia wholly black.

Dorsum of thorax and abdomen shining bronze-green, the former almost blackish; pleura and venter of abdomen dull black; abdomen with black hair; hypopygium moderately large, black, its lamellae (Fig. 37) black, fringed with stiff black hairs, somewhat crescent-shaped, usually closely applied to the end of the hypopygium, so that only the outer edge shows

Coxae and femora black, narrow tips of coxae, all trochanters, extreme base of femora yellow, the moderately wide tips of front and middle femora and extreme tips of hind ones yellow; coxae with black hair and bristles; femora without long hair below, middle and hind ones with one preapical bristle; upper surface of front tibiae with a pair of small bristles near basal fourth, a large bristle at the middle and a row of small bristles or bristle-like hairs on upper posterior edge, which are longest toward the base, very short at the tip, the bristles beginning at the basal fourth, where they are about as long as the diameter of the tibiae; middle tibiae with one long bristle at apical third of lower anterior edge; hind tibiae usually brown or black at tip; tarsi black with first segment more or less yellow; length of front tibiae as 55, middle as 69 and posterior as 100; segments of front tarsi as 30-14-9-8-8; of middle pair as 37-18-15-10-9; those of posterior ones as 28-32-24-16-11. Calypters and halteres yellow, the cilia of the former black.

Wings slightly tinged with brownish; third vein bent backward a little more at tip than the last section of the fourth vein, so that it approaches the fourth at the tip a very little; fourth vein nearly straight and ending in the apex of the wing; last section of fifth vein nearly straight, its length as 40, cross-vein about as 20; anal angle of wing rounded, but rather prominent.

Types.—Described from nineteen males, all taken by W. J. Brown, in Quebec, in 1930. Holotype and eight paratypes, at Bradore Bay, July 12 to August 1; and six paratypes at Thunder River, June 21–23. Types in Canadian National Collection.

Gymnopternus browni is nearly like *tristis* Loew, but *tristis* has the third antennal segment about as long as wide and with very short pubescence, the hypopygial lamellæ larger and the row of little bristles on the front tibiæ of more even length; my specimens of *tristis* are from Alaska, where the type was taken. The femora in both *tristis* and *browni* are sometimes largely yellowish brown, especially below.

Hercostomus (Gymnopternus) nigrifacies, new species

Length, 3–3.5 mm

Male.—Face rather wide above, narrowed below, black with black pollen; palpi black; antennæ (Fig. 38) black, third segment somewhat conical in outline; front black, vertex and occiput dark green with a little brown pollen; orbital cilia wholly black.

Dorsum of thorax and the abdomen dark blue-green, the former with a little brown pollen, which is visible only when seen obliquely; hairs of abdomen black; pleura black. Hypopygium (Fig. 39) and its lamellæ black, the former sessile; lamellæ rather small, fringed with moderately long hair, somewhat crescent-shaped; inner appendages enlarged at tip and with a long hair on the side; central organ about as long as the hypopygium; abdomen with long bristles on posterior margin of fifth segment, these bristles nearly twice as long as the bristles on the other segments

All coxæ, femora, and the hind tibiæ black; front and middle tibiæ dark yellow, or yellowish brown, sometimes almost blackish; front coxæ with rather long black hair and long bristles, one of which is near the apical third; middle and hind femora each with one preapical bristle and a row of moderately long hairs on lower surface; upper surface of front tibiæ with a pair of small bristles beyond basal fourth and a larger single bristle at the middle, none below; middle tibiæ with a pair of large bristles above at basal fourth, a single one at basal third and a pair at apical third, below with one large bristle at apical third; hind tibiæ with seven bristles above and one below, which is near apical fourth and another small one near the middle below; length of front tibiæ as 49, of middle as 68, and of posterior pair as 92; segments of front tarsi as 25–10–8–5–5; of middle pair as 33–18–14–10–8; those of posterior pair as 22–27–20–13–10. Calypters and halteres yellow, the cilia of the former black

Wings a little tinged with brown, darker in front of third vein, which is nearly straight; last section of fourth vein nearly parallel with third, ending just in front of the apex of the wing; posterior margin of wing evenly rounded, the anal angle being rather full, but not prominent; last section of fifth vein straight, its length as 47, cross-vein as 20

Female.—Face dark grayish pollinose; front and middle tibiæ dark yellowish brown, sometimes almost black; otherwise about as in the male.

Types.—Described from seven males and nine females, all taken by J. Wilcox, May 24, 1931, at Newport, Oregon.

H. nigrifacies belongs to a group of four species which have all the femora, hind tibiæ and hypopygial lamellæ black. This group contains,

besides the present species, *tenuicauda* Van Duzee, *tibialis* Van Duzee, and *brevipes* Van Duzee; it differs from all of those in having the face black, in which character it agrees with *tristis* Loew, but that species has all the tibiae yellow, the posterior pair with a blackish tip. My specimens of *tristis* are from Alaska, the type location, and have the inner hypopygial appendages boot-shaped, not rounded and club-shaped as in *nigrifacies*.

***Hercostomus (Gymnopternus) ovaticornis*, new species**

Length, 2.5 mm

MALE —Face rather narrow, black in the type (probably white pollinose in well-preserved specimens) Palpi black; front black like the face Antennae black, third segment slightly longer than wide, oval, broadly rounded at tip with rather long pubescence on third segment and arista; orbital cilia wholly black.

Abdomen green with bronze reflections and black hair; hypopygium of about the usual size, black, its outer lamellae rather small, dark yellow, fringed with black hairs

Coxae and femora black; hair on front coxae black; all tibiae yellow, posterior pair with apical fourth black; front tibiae with one bristle near middle on posterior surface and a row of small bristles on upper posterior edge with two longer bristles among them; middle tibiae with one bristle above just before basal fourth, none below; hind tibiae with one bristle below at apical third and several short bristles, or bristly hairs, above with three pairs of large bristles; length of front tibiae as 57, of middle as 62 and of posterior as 67; length of the segments of front tarsi as 18-9-7-5-7; of hind tarsi as 20-25-18-12-9 Calypters and halteres yellow, cilia of former black.

Wings grayish; last section of fourth vein and the third vein nearly straight and parallel; last section of fifth vein straight, its length as 34, cross-vein as 13; anal angle of wing rounded, not very prominent

TYPE —Holotype, male, taken May 2, 1910, at Great Piece Meadows, New Jersey

H. ovaticornis is almost like *singularis* Van Duzee, described from Rhode Island, but that species has the third antennal segment pointed at the tip, while in this species the third segment of the antennae is broadly rounded, not at all pointed.

***Paraclius coxalis*, new species**

Length, 3.5 mm.; of wing, 3.3 mm

MALE —Face narrow, a little wider above, silvery white, not quite reaching the lower margin of the eyes; front and occiput green with considerable white pollen; palpi very small, brown with yellow hairs; antennae (Fig. 40) yellow, brown on apical third, pointed at tip, arista black with long pubescence; orbital cilia almost wholly yellowish white

Dorsum of thorax shining blue-green, the posterior part more blue; the velvety black stripe above root of wing distinct and reaching the suture; the white pollinose spot at the suture large, but not silvery. Abdomen shining green with large spots of white pollen on the sides of the segments and black hair; seventh segment black, ring-

like; hypopygium (Fig. 41) black, a little yellow below, with a short peduncular segment, its appendages yellow, outer lamellæ (Fig. 42) large, yellow, blackish, and pointed at tip

All coxæ, femora, tibiae and the front tarsi pale yellow, middle and hind tarsi black with first segment dark yellow; front coxæ with black hair and four large bristles, two at tip and two on apical half of outer anterior edge, also two or three very small bristles at base in front; front tibiae above with a pair of rather short bristles at basal third, one at middle and one near tip, also a row of stiff hairs above and below on posterior surface; first segment of front tarsi with a row of bristly hairs below, several near the base longer than the diameter of the segment; middle tibiae with a pair of bristles below near the middle, above with four long bristles on anterior and three on posterior edge, also two near tip; hind tibiae below with a pair of bristles of moderate length beyond the middle, and several small ones, above with four pairs of large bristles, and a single one at apical tenth; middle and hind tarsi with abundant stiff hairs; length of front tibiae as 59; of middle as 79, and of posterior as 114; segments of front tarsi as 33-10-8-7 6; of middle as 39-15-15-10-7; and of posterior as 25-45-25-15 7. Calypters and halteres yellow, the former with black cilia

Wings a little grayish; third vein a little bent backward toward tip, last section of fourth vein quite abruptly bent at its middle, rounding forward so as to be concave posteriorly (the venation is typical of the genus); last section of fifth vein only slightly arched, its length as 32, cross-vein as 21; anal angle of wing prominent

TYPE—Male, taken in February or March, 1931, at Santa Emilia, Pochuta, Guatemala, by Dr. J. Bequaert.

Paraclius corahis is very much like *viridis* Van Duzee, from Honduras, but that species differs in having the third antennal segment largely brown, rounded at the tip, the hypopygium with a curved peduncular segment one-third as long as the hypopygium; the middle tibiae below with one bristle near the basal and one near the apical third; hind tibiae with one bristle below at the apical third; last section of fifth vein slightly longer than the cross-vein and the last section of the fourth vein beyond the cross-vein running nearly straight to its tip.

Paraclius fraternus, new species

Length, 3 mm., of wing the same.

MALE. Face of moderate width, a little wider above, silvery white; palpi yellow with black hairs; front and occiput green, white pollinose; antennæ (Fig. 43) dark yellow, third segment blackish, slightly longer than wide, obtuse at tip, arista inserted above the tip, one-fifth shorter than the front femora, its pubescence short, the tip a little enlarged, elongate-oval; upper half of orbital cilia black, lower half yellowish white and with bristly black hairs below the neck

Dorsum of thorax green with grayish pollen, and a rather wide, median, brownish coppery stripe; abdomen green or coppery; hypopygium blackish, its lamellæ black (Fig. 44), rounded with a distinct petiole and a very long acute point extending backward from its upper edge, fringed on outer edge with long yellowish hairs.

Front coxæ yellow, sometimes a little darkened at extreme base on outer surface and with a few black hairs and long bristles; middle and hind coxæ black with narrow

yellow tips; all femora and tibiae yellow, all tarsi yellowish at base, black from tip of first segment, plain, with only a few minute spines below; all femora with a few rather short yellowish hairs below; length of anterior femora as 54, of their tibiae as 52; length of middle tibiae as 79, posterior as 98; segments of anterior tarsi as 18-6-5-4-6; of middle pair as 32-18-15-10-10; of posterior pair as 24-31-21-15-10 Calypters and halteres yellow, cilia of former black

Wings grayish; third vein straight; last section of fourth vein from the cross-vein to bend as 40, from bend to apex of wing as 29; cross-vein nearly perpendicular to the axis of wing; fourth vein reaching the wing margin before the apex of the wing, scarcely parallel with third at tip.

Types —Described from four males, taken by C. H. Curran, July 5 and 9, at Cold Spring Harbor, Long Island, New York.

P. fraternus is one of three forms with the arista enlarged at the tip. The first, *claviculatus* Loew, was described in 1866, the type being taken just across Long Island Sound from where these specimens were taken. According to Loew's description *claviculatus* differs from *fraternus* in having the wings blackish and the hypopygial lamellæ with a filament attached to the side at the base. Dr. Aldrich described *discifer* in March, 1902, from specimens taken on the island of Granada, West Indies, and this must have the hypopygial lamellæ much as in *fraternus*, but differs in having the antennal arista longer than the anterior femora. In *fraternus* the arista is to the front femora as 44 to 54. Dr. Aldrich also states that the bend in last section of fourth vein is very obtuse and at its middle, while the bend in *fraternus* is quite sharp and considerably beyond its middle. All three species may prove to be the same, but I scarcely think it possible.

Paraclius sordidus, new species

Length, 3.1 mm.

MALE —Face in the middle as wide as third antennal segment, one and one-half times as wide above, silvery white, suture near lower part, making the lower part about as long as wide, rounded below; palpi small, black with the hairs mostly yellow; front blue-green with considerable white pollen; antennæ (Fig. 45) yellow, third segment with apical two-thirds brown, pointed at tip, one-third longer than wide, arista inserted near the middle, with long pubescence; occiput green, white pollinose; lower orbital cilia white.

Dorsum of thorax brownish green with blue reflections, its pollen white, giving it a somewhat spotted appearance; pleura wholly black with green reflections, thickly white pruinose; acrostical bristles rather long, in two rows; dorsocentrals five in a row. Abdomen bronze-green, with white pollen and black hair, last segment black, small, covered with white pollen; hypopygium (Fig. 46) black, the small peduncular segment reddish brown, the outer lamellæ moderately large, yellowish brown and rounded on apical margin, the inner appendages small, yellow.

All coxæ, femora, tibiae, and the front tarsi wholly yellow; front coxæ with black hair and four large bristles near tip; all femora with short hair below; front tibiae with

three rather large bristles on upper anterior, and two on upper posterior edge, also a row of black bristly hairs on upper anterior edge; upper surface of posterior tibiae with two pairs of large bristles on basal half, a pair of small ones near base, the apical half with three large bristles, besides two at tip, lower anterior edge with one moderately large bristle near apical third; upper surface of middle tibiae with a pair of small bristles near base, a pair of large ones at basal fifth, and four large single bristles on apical three-fourths, also four at tip, below with one large bristle at apical third of lower posterior edge; front tarsi with a row of bristle-like hairs below, the one at base as long as diameter of segment; middle tarsi with a bristle below at base, which is twice as long as diameter of segment; middle and hind tarsi yellow, appearing quite brown toward apical end; length of front tibiae as 54, middle as 69 and posterior as 103; segments of front tarsi as 29-10-8-6-5; of middle as 35-21-19-11-8; and of posterior as 25-36-24-17-8. Calypters and halteres yellow, cilia of the former black.

Wings grayish; third vein only slightly bent back at tip; last section of fourth vein abruptly bent beyond its middle, arched so as to make the apical part concave posteriorly; last section of fifth vein much curved, ending in a notch in hind margin of wing, its length as 17, cross-vein as 15; anal angle of wing rounded, but quite prominent.

HOLOTYPE.—Male, taken in February or March, 1931, at Santa Emilia, Pochuta, Guatemala, by Dr. J. Bequaert.

This form is near *viridis* Van Duzee and *coxalis*, new species. It differs from *coxalis* in having the posterior edge of the pleura wholly black, third antennal segment only one-half longer than wide, and the hypopygial lamellæ somewhat different. From *viridis* it differs in having the dorsum of the thorax dull, in having no distinct velvety black stripe above root of wing, and in having only a short peduncular segment to the hypopygium.

***Paraclius angusticauda*, new species**

Length, 3 mm.

MALE.—Face narrow below, about as wide as third antennal segment at the antennæ, shining green above, silvery white below this green, which extends down about as far as the width of front which is also shining green; palpi small, black; antennæ (Fig. 47) wholly black, the third segment rather large, straight above, rounded below and a little pointed at tip; arista dorsal, short pubescent on basal half, pubescence longer on apical half; lower orbital cilia dark yellowish.

Thorax green, dorsum shining and with a median coppery stripe on the anterior two-thirds; pleura white pruinose. Abdomen green, covered with white pollen and black hair, hairs on the sides and venter a little yellowish, the last segment wholly white pollinose; hypopygium (Fig. 48) black (its base and the small peduncular segment a little reddish brown), rather long and slender, outer lamellæ brown or yellowish brown with short yellow hairs, oval, twice as long as wide, inner appendages comprising a pair of smooth, yellowish, curved, horn-like organs.

Front coxæ yellow, distinctly blackened at base for a short distance, with rather long and abundant black hairs and five bristles, four at tip and one on outer anterior edge; middle and hind coxæ almost wholly black; trochanters, femora, and front and

middle tibiae yellow, hind femora black above at tip; hind tibiae black with a narrow yellow line above between the rows of large bristles, but in certain lights the anterior surface appears a little yellowish; all tarsi black or brown almost to their base; front tibiae with three large bristles above, one at basal third, one at the middle and one beyond apical third, between them are a few short bristle-like hairs, no bristles below; middle tibiae with four pairs of bristles above, besides those at tip and a large bristle at the middle below; hind tibiae above with four bristles on each edge, besides those at tip; below with a row of rather long, bristle-like hairs on anterior edge, hind femora with rather long hair both above and below; last segment of front tarsi a very little widened; hind tarsi a little thickened and with rather dense long black hair; length of front tibiae as 40, middle pair as 68, and posterior ones as 86; segments of front tarsi as 19-7-5-4-6; of first three segments of middle tarsi as 33-20-18; of posterior tarsi as 27-33-28-18-10. Calypters and halteres yellow, the cilia of the former black.

Wings gray, very slightly tinged with brown, especially in front; third vein nearly straight; last section of fourth vein gently bent considerably beyond its middle, arched so as to be a little concave posteriorly; last section of fifth vein slightly curved, its length as 23, cross-vein as 12, and at right angles with fourth vein; wings narrower than usual, but the anal angle a little prominent, the wing being of somewhat equal width.

HOLOTYPE.—Male, taken in March or April, 1931, at Moca, Guatemala, Guatemala, by Dr J Bequaert.

Parachus angusticauda is very much like *elongatus* Van Duzee, from St. Vincent, West Indies, but that species has the hind coxae yellow, a little black at the base; hind tibiae yellow; middle tibiae with two bristles below, front tarsi largely yellow, middle tarsi black from the tip of the first segment, wings with bend in last section of fourth vein abrupt, broadly rounded, at the middle of the last section of the fourth vein, the apical part considerably concave posteriorly and the first two segments of hind tarsi are as 27-15; in *angusticauda* the first two segments of the hind tarsi are as 27-33. It is possible that the third segment in *elongatus* was broken off, as the length of only two segments was given, but the second segment of the hind tarsi is sometimes much longer than the first in this genus, often very nearly equal, but usually the second segment is much the longer.

Sarcionus obtusus, new species

Length, 4 mm.

MALE.—Face fully as wide in the middle as width of third antennal segment, a little wider above and below, silvery white, lower part slightly longer than wide, rounded below; palpi yellow with black hair; proboscis black; antennae (Fig. 49) yellow, the third segment mostly blackish, obtusely pointed at tip, about as long as wide, arista inserted near the middle, feathered with long hairs; front and occiput green, thickly white pollinose; orbital cilia black, about six of the lower cilia on each side yellow, a black bristle near the lower end of the posterior orbits.

Dorsum of thorax and scutellum dark, shining green with a little white pollen along the front; acrostical bristles large, in two rows; dorsocentral bristles six in each row; scutellum with one pair of large bristles and a long hair outside of these on the margin; pleura wholly black, with green reflections and white pollen. Abdomen black with slight green reflections, spots of white pollen on the sides of the segments; hypopygium black, the inner appendages and lower edge yellow, with a short reddish-brown peduncular segment, its lamellæ with the apical part whitish, nearly oval in outline with mixed pale and black hairs on the edge, its petiole a little yellowish (about like that of *Parachius obscurus* Van Duzee, Bull. American Museum of Natural History, LXI, Art. V, p. 205, Fig. 49).

All coxæ, trochanters, femora, tibiæ and front tarsi yellow; front coxæ with black hairs and bristles; middle and hind coxæ a very little blackened at base; last segment of front tarsi brown; middle tarsi yellow, becoming brown toward the tip; hind tarsi almost wholly black; femora nearly bare below; front tibiæ above with one pair of bristles near basal fourth, one bristle beyond the middle and a pair near the tip, no bristles below, but with a long wavy hair below at tip; middle tibiæ with five long stout bristles at tip and one slender one below at tip, and two large bristles on lower middle third, above with five on basal two-thirds, besides three small ones near base; posterior tibiæ with four large bristles on upper posterior and three on upper anterior edge, none below; length of front tibiæ as 65, middle as 126, and posterior as 129; segments of front tarsi as 40-20-13-7-7; of middle as 50-32-21-13-8; of posterior pair as 30-50-30-19-9. Calypters and halteres yellow, cula of former black.

Wings grayish, slightly darker toward the front, the root of the wing yellow; third vein bent backward a little at the tip; last section of fourth vein abruptly bent at the middle, curved so as to be concave posteriorly; last section of fifth vein curved, equal to the cross-vein in length.

TYPE.—Holotype, male, taken in March or April, 1931, at Moca, Guatallon, Guatemala, by Dr. J. Bequaert.

Of the described species of *Sarcionus* this would come nearest *rotundicornis* Van Duzee, but that species has black palpi, third segment of antennæ broadly rounded at the tip, lateral and inferior orbital cilia white, bend in last section of fourth vein a little before its middle, and the last section of the fifth vein about one-fifth longer than the cross-vein.

Pelastoneurus abbreviatus Loew

Mr. C. H. Curran took many specimens of what I have been determining as *abbreviatus*, and I find that the long pale hairs on the tips of the inner hypopygial appendages (Fig. 50) are branched. Mr Curran's specimens were taken at Cold Spring Harbor, Long Island, N. Y., in June and July, 1930. I had not noticed the branching of these hairs before and Dr. Loew does not mention them in his description, which was made from specimens taken at New Rochelle, N. Y., nearly across Long Island Sound from where these were taken. As they agree well with his description in other respects they are no doubt correctly determined.

Pelastoneurus bequaerti, new species

Length, 3.5-4 mm.

MALE.—Face rather narrow, wholly silvery white when viewed from in front, the upper part yellowish brown when seen from below, its suture near apical third, rounded below; front dark green, covered with white pollen; palpi small, yellow, with the hair mostly black; antennæ yellow, third segment blackened at tip, about as long as wide, tip a little rounded, arista feathered with long hairs; lower orbital cilia white.

Dorsum of thorax and scutellum shining, very dark blue-green; the velvety black stripe above root of wing distinct, the silvery pollinose spot at the suture large; humeri shining black; pleura black, white pruinose. Abdomen shining black with black hair and spots of white pollen on the sides of the segments; hypopygium (Fig. 51) black, with long yellow appendages below, which make it appear yellow below, its lamellæ yellowish white with a brown apical border, hairs on the edge yellow, rather stiff but not very long, disk with minute white hairs.

All coxæ yellow, middle pair blackened on basal half of outer surface, front pair with small black hairs and about seven bristles, five across the tip and two on outer anterior edge, the upper one smaller and above the middle; femora and tibiae yellow, hind tibiae dark at tip; front tibiae with two very slender bristles above, one at the middle and one near tip, its length as 70; they have no bristles below; middle tibiae with two bristles below on middle third of anterior edge; hind tibiae with a row of stiff black hairs below, which do not reach base or tip; middle and hind tibiae with the usual large bristles above; front and middle tarsi yellow or yellowish brown, darker toward their tips; hind tarsi almost wholly black or dark brown; segments of front tarsi as 42-17-14-9-8; of middle as 46-31-13-14-8; of posterior pair as 43-53-27-19-11. Calypters and halteres pale yellow, the cilia of the former black.

Wings dark gray; third vein nearly straight; last section of fourth vein bent beyond its middle, its tip close to tip of third, the apical part concave posteriorly, from the cross-vein the bend as 52, from bend to tip as 42; last section of fifth vein curved and partly represented by a fold in the wing, which ends in a notch in the hind margin of the wing, its length as 22, cross-vein the same length.

FEMALE.—Color about as in the male; third antennal segment as long as wide; face wider than in the male, but narrow for a female, its pollen as in the male; palpi and proboscis yellow; femora and tibiae paler yellow than in the male, tarsi colored as in the male; fore tibiae with three slender bristles above; middle and hind tibiae with their hair and bristles about as in the male; last section of fifth vein straight, reaching half-way to wing margin, which is not notched, being scarcely indented; otherwise about as in the male.

TYPES.—Described from four males and one female, all taken by Dr. J. Bequaert, in March and April, 1931, at Moco, Guatallon, Guatemala.

P. bequaerti is separated from *versicolor* Van Duzee, from Cuba, by the hypopygial lamellæ being yellow and the margin of the lamellæ being evenly rounded, not jagged. In *versicolor* the lamellæ are jagged and bristly on the apical margin and almost wholly black, and also the third antennal segment is twice as long as it is wide.

***Pelastoneurus minutus*, new species**

Length, 2.5 mm ; of wing 2 mm

MALE.—Face rather wide, wholly opaque, being wholly covered with brown pollen, its suture near apical fourth, lower part a little wider than long, rounded below; front bright violet with a little brown pollen above the antennæ; occiput green, a little dulled with brown pollen; palpi black; antennæ yellow, third segment yellow at base, but mostly brown, rounded at tip, arista feathered with rather short hairs; orbital calia wholly black.

Dorsum of thorax and scutellum covered with thick brown pollen, which leaves two rather wide, shining violet stripes, one each side of a brown pollinose stripe, in which the acrostical bristles are inserted; scutellum bright violet in the middle; sides of the dorsum of the thorax green. I cannot see any black velvety stripe above root of wing or silvery spots on the sutures. Abdomen green with bronze reflections, black hair and spots of white pollen on the sides of the segments; hypopygium of the usual size, black, its outer lamellæ are mostly concealed by the legs in the type, but appear to be rather small and wholly black with black hair.

Front coxæ yellow, largely blackened on basal half of outer surface, wholly yellow on inner side, their hair black, bearing three black bristles in a row from the tip upwards; all femora, tibiæ and base of all tarsi yellow; no long hairs on lower surface of femora; front tibiæ with one large bristle on posterior side beyond the middle, their length as 47 and about one-fourth longer than their tarsi; middle tibiæ on upper surface with a pair of large bristles at basal fourth, one bristle beyond these and another just beyond the middle, no bristles below, their length as 69; segments of front tarsi as 13-7-6-5-7; of middle pair as 25-17-14-8-7; of posterior pair as 22-33-24-14-10. Calypters yellow with black calia; halteres black.

Wings dark grayish, almost brownish; last section of fourth vein bent before its middle, its tip close to tip of third vein, veins brown.

TYPE.—Described from one male, taken October 26, 1916, at Baraland, Mobile Co., Alabama.

Pelastoneurus minutus comes nearest to *aurifacies* Van Duzee. It has the face brown pollinose, not at all yellow, the suture of the face is near the middle in *aurifacies* and at the apical fourth in this. In *minutus* the front tibiæ are about one-fourth longer than their tarsi, while in *aurifacies* the tibiæ and tarsi are of nearly equal length.

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A SECOND BARN-DOOR SKATE, *RAJA STABULIFORIS*, WITH PECTORALS NON-ADHERENT TO THE HEAD

By E. W. GUDGER

It is interesting to note that two specimens of the same skate, having exactly the same type of abnormality, have been captured in the same general locality, Woods Hole, Massachusetts, by the same collector, Mr. Robert A. Goffin of the Bureau of Fisheries station. Moreover, both fish are males. The first was taken in 1924 in a fish-trap in Menemsha Bight, east of Gay Head in Vineyard Sound. The second was captured with an otter-trawl on December 1931, about 20 fathoms down and about 25 miles southwest of Nantucket Island. The first specimen is in the collections of the U. S. National Museum at Washington. With the permission of the officials of the Bureau of Fisheries, the second specimen was presented by Mr. Goffin to the American Museum, and is now in my keeping.

THE FIRST DEFORMED SKATE

The first specimen (1924) was identified by Mr. Lewis Radcliffe and was described by him in an article published in *Natural History* in 1928.¹ It will be well briefly to redescribe this first specimen, shown herein in dorsal and ventral views in figures 1 and 2, in order that direct comparisons may be made of it with the present specimen.

As the figures show, it is an immature male with the pectorals separated from the head by deep and wide notches. The complete measurements of this specimen will presently be set alongside those of the second fish. Here it is enough to say that the fish shown in figures 1 and 2 is 20.5 inches long over all, and 12.75 inches wide; while the length of the head, from tip of snout to the midpoint of line joining the bases of the right and left notches, is 5.25 inches. The right notch is slightly deeper than the left—5.5 inches right and 5.25 inches left. From this, and from the figures, it is seen that the fish is slightly asymmetrical. This asymmetry is even more plainly seen when one considers the relative position of the gill-slits as shown in figure 2. On the left

¹Radcliffe, Lewis, 1928. 'A Barn-door Skate (*Raja stabuliformis*) with Abnormal Pectoral Fins.' *Nat. Hist.*, XXVIII, pp. 58-63, 7 text-figs.

side two slits are shown anterior to the notch where head and pectoral meet, while on the right there are three slits above the notch. Other than in these points named, this young ray seems entirely normal.

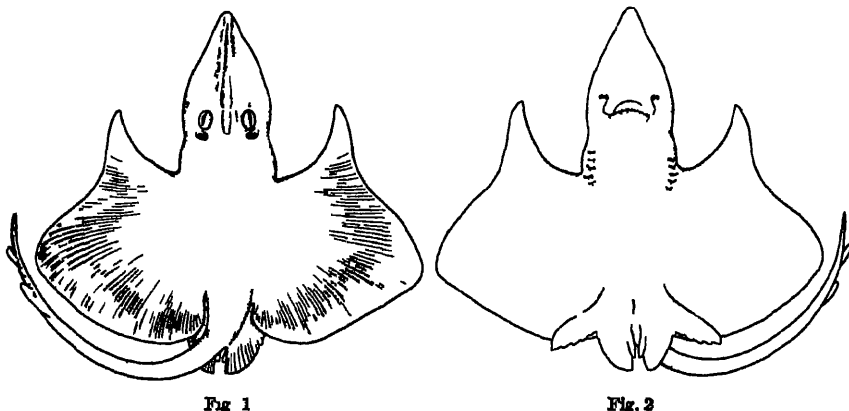


Fig. 1

Fig. 2

Fig. 1. Dorsal aspect of *Raja stibularis* (No. I) from Woods Hole. The head and pointed pectorals are separated by wide notches, that on the right being deeper. After Radcliffe, 1928.

Fig. 2. Ventral view of abnormal barn-door skate No. I. The right-hand notch has three gill-slits above it; the left notch has but two.

After Radcliffe, 1928.

THE SECOND MALFORMED SKATE

The second ray is shown in both dorsal and ventral view in figures 3 and 4. It is also an immature male, as the very small claspers indicate, and is in the same stage of development as is the preceding. It measures 19 inches over all, and 12.25 inches in extreme breadth. The head from the extremity of the snout to the midpoint of a line joining the notches is 4.75 inches long. Like fish No. I, the right-side notch is deeper than the left—5.25 inches compared with 4.9.

Not so apparent as the wide notches between head and pectorals, but even more interesting, is the number and position of the gill-slits. On the left side there are five, decreasing somewhat uniformly in size from front to rear, the fifth being only about half as wide as the first. Unlike those of the first specimen, which has two gill-clefts anterior to the notch, all these are located well behind the notch on the left side. Those on the right side, however, are only four in number, and two of these are located above the notch, the third slightly below the base of the notch, and the fourth well behind this. Slits one and two on the

right side are about of a size, and only about half the size of slit number three; the largest, number four, is also about equal in size to numbers one and two. Most remarkable of all is the fact that, in the hinder wall of gill-slit number four, there is the rudiment of the last (fifth) right gill-slit. The opening is there, as may be seen in figure 4, about one-third as wide as is that of gill-slit number four. This slit ends in a blind sac about one-

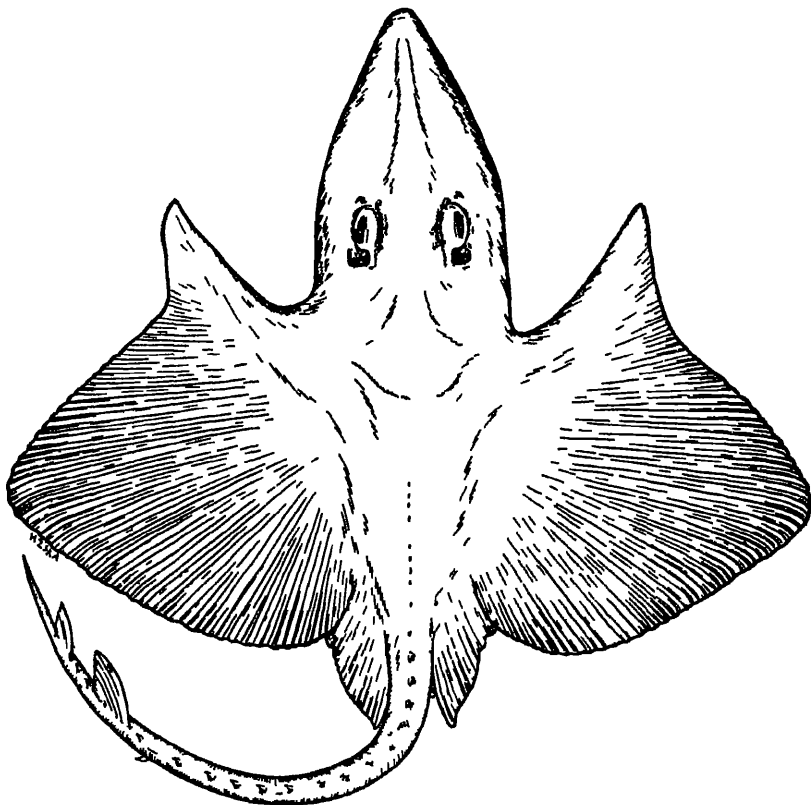


Fig. 3. Dorsal view of barn-door skate No. II from Woods Hole. The abnormality is identical with that of specimen No. I, the right notch being deeper.

fourth inch beneath the surface. It should be noted before leaving these structures that the right gill-slit of fish No. I is of about the same size and width as right gill-slit three of the present specimen.

The base of the notch on the left side of specimen No. II is 4.9 in. from the end of the snout, while the first gill-slit on that side is 5 in.

from the same point. The base of the right notch is about 5.25 in. from the tip of the snout, and the first gill-slit is about 4.9 in. from the same point of reference. Gill-slits number two are about the same distance from the tip of the snout, and are about opposite each other (see Fig 4). The gill-slits on the right seem nearer the tip of snout because of the deeper cleft on that side.

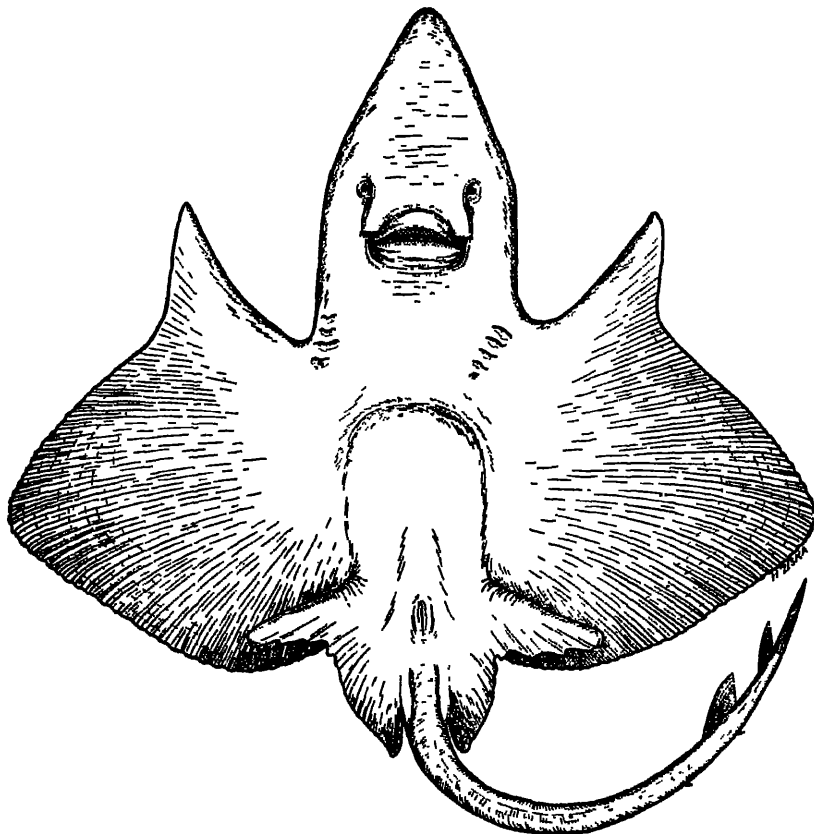


Fig. 4. Ventral aspect of ray No. II. Two right gill-slits are above the notch, the third is even with it, the fourth and the included fifth are below. On the left all five are well below the notch.

Other than in the matter of the notches on the right and left sides of the head, the relative size of the gill-clefts, and particularly in the matter of the rudimentary fifth slit on the right, this second young specimen of the barn-door skate seems normal.

In the table the relative measurements of the two specimens are contrasted. Ray No. I is Radcliffe's specimen, while No. II is mine. The measurements are all made in straight lines and recorded in inches.

MEASUREMENTS OF RAYS WITH NON-ADHERENT PECTORALS

Ray Number	I	II
Length over all	20 5 in.	19 0 in.
Length body proper (snout to hunder edge vent)	9.8 in.	9.4 in.
Length tail (hunder edge vent to tip)	10 7 in	9 6 in.
Length snout tip to midpoint of line joining notches	5 25 in.	4 75 in.
Length snout tip to right-side first gill-slit	4 9 in.	5.00 in.
Length snout tip to left-side first gill-slit	4 7 in.	4 9 in.
Length right horn of pectoral to base of cleft	3 0 in.	2 75 in.
Length left horn of pectoral to base of cleft	2 75 in.	2 4 in.
Width over all	12 75 in.	12 25 in.
Width head at bottom shallow cleft	3 25 in.	3 25 in.
Width between eyes	1 0 in.	0 9 in.
Width tip to tip horns of pectorals	7 25 in.	7 1 in.
Width tip to tip pelvics	5 6 in.	5 5 in.
Depth snout to base right notch	5 5 in	5 25 in.
Depth snout to base left notch	5.25 in.	4 9 in.

HISTORICAL NOTES

There is a rather extensive literature of this pectoral abnormality in skates and rays. This goes far back, even to the earliest printed works dealing generally with fishes—those great folios in which were laid the foundations of the natural history of fishes. However, this is not the place to figure and describe, or even refer to the bishopfish, monkfish,

or priestfish of Belon (1551), Rondelet (1554), Gesner (1558), and Aldrovandi (1613 and 1640). Some of these figures show the influence of mythological ideas, but were undoubtedly based on such malformed rays as are figured above. Such no doubt is that shown in figure 5, though it has plainly been manipulated by hand and dried to form the monster as portrayed by Aldrovandi. I have seen present-day manipulations produce comparable apparitions. Some day I hope to bring a large number of these figures together, as an interesting chapter in the history of ichthyology.

In modern ichthyological literature there is a large list of such teratological specimens extending from 1810 to 1932. Thus far, I have accumu-

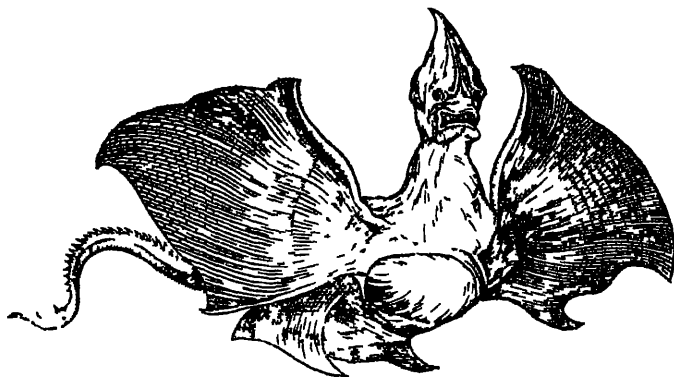


Fig 5 The priestfish. A malformed, hand-manipulated, dried ray with which the artist took many liberties in his drawing.

After Aldrovandi, 1613

lated 35 in my file marked "Malformed Rays." Close search through the literature will undoubtedly bring others to light. I hope some time to bring together all these modern accounts with their interesting figures in an article covering the field thoroughly. To do so now is beyond the purpose of this short article. However, it may not be out of place to give three short references, in order to make a historical setting for the malformations of the barn-door skate.

Present-day knowledge of these monstrous forms began with an account of such a ray taken on the coast of Sicily and described in 1810 by that strange genius, Constantine Rafinesque-Schmaltz.¹ He thought it was a distinct genus and gave its characters as follows (free transla-

¹Rafinesque-Schmaltz, C. S. 1810. 'Indice d'Ichtiologia Siciliana.' *Mezzana* (*Cephalothurus*, p. 61.)

tion): "Head free and separated from the lateral wings; eye and spiracles united [near to each other] and situated on the side of the head; two fins above the tail, none at the extremity." Then he adds: "This genus is most remarkable because of the characters exhibited by its free head, which in all other genera is united to the lateral or it may be pectoral

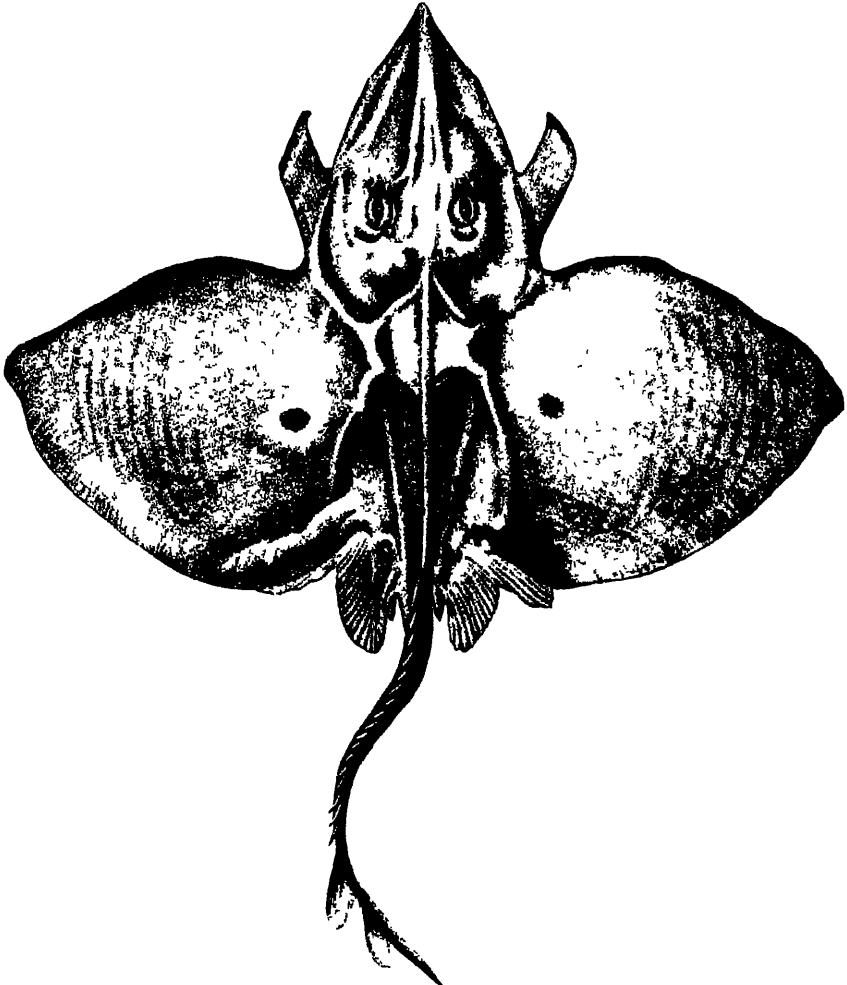


Fig. 6. *Propterygia hypostica*, a so-called new genus and species of ray. Here a second split has divided each pectoral fin into an anterior horn and a posterior fin.

After Otto, 1821

wings [fins]." He names his form *Cephaleutherus maculatus*, and notes that its head is pointed and that the lateral fins are also pointed. He unfortunately gives neither measurements nor figure.

The next describer was the Breslau naturalist, A. W. Otto,¹ who in 1818 obtained from a fisherman at Edinburgh one of the most greatly malformed rays ever figured and described. As may be seen in figure 6, this differs markedly from our two Woods Hole specimens. First there is the normal split between the head and pectorals; then in some way not clear the fins have become split again to form two forward-pointing anterior horns and the two lateral wings. Otto also thought that he had a new genus and species, which he named *Propterygia hypostica*. His fish

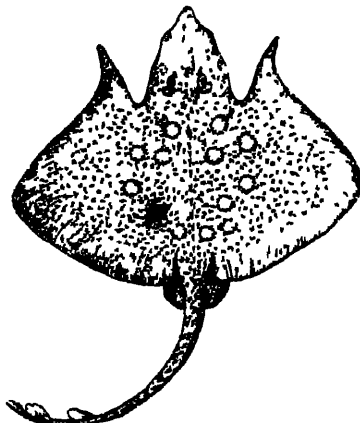


Fig 7. *Hieioptera abredonensis*, the Aberdeen priestfish. It has the same type of abnormality as that found in the Woods Hole specimens.

After Fleming, 1841.

was small—18 inches long (equally divided between body and tail) and 13 inches wide. His figure was evidently made after the specimen had become dried.

The next specimen to be figured and described (so far as I can find out) dates twenty years forward. In 1841, Flemming² described, also from Scottish waters, a teratological ray which he thought was a new genus and species, and which he called *Hieioptera abredonensis* (the priest-winged fish from Aberdeen). This is shown as figure 7 herein. It is very like the two Woods Hole fish, and needs no further description

¹Otto, A. W. 1821 'Ueber eine neue Rochs (*Propterygia hypostica*),' etc. Nova Acta Acad. Leopoldino-Carolinae, X, pp. 113-121, 2 plates

²Flemming, John 1841, 'Description of a Species of Ray New to the British Fauna' Edinburgh New Philos. Journ., XXXI, pp. 236-238, 2 plates

From this time on, the literature becomes too voluminous and complex to be covered satisfactorily in this short article. It is my intention later to collect and present it in definite form with all the interesting figures to show how, only after a period of 75 years, the matter was thoroughly cleared up—by Theodore Gill in 1896.

HOW THIS CONDITION COMES ABOUT

The explanation is to be found in the embryology of the skate. The skates and rays are highly specialized forms of the great group *Elasmobranchii*—forms which have evolved beyond the sharks by developing modifications for bottom-living. To this end the round body of the shark has become flattened, the pectorals have become enormously en-

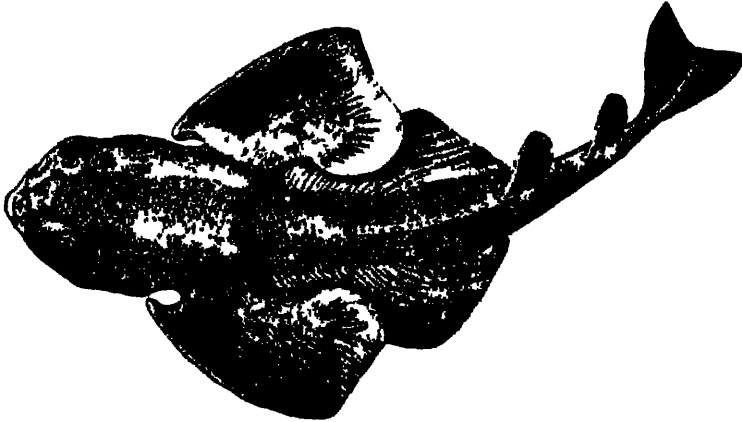


Fig. 8. The angel shark, *Rhina squatina*, an intermediate form between shark and ray. Note the permanent notch between pectorals and head.

After Boulanger, 1904

larged and have become adherent to the neck and head region. In this process, the gill-openings have been forced from a lateral to a ventral position. In the angel shark, *Rhina squatina*, is found an excellent connecting link. In it, as may be seen in figure 8, the body is much flattened, the gill-slits are on the ventral surface, and the pectorals (also the pelvics) have become greatly enlarged. However, the pectorals are not yet adherent to the head, but are separated from it by conspicuous notches. These are morphologically identical with the notches that separate the "wings" from the head of the specimens of *Raja stabuliforis* from Woods Hole.

This matter will be made clearer by study of figure 9, which was drawn from the larval form of the sting-ray, *Dasyatis say*. This baby ray I cut from the uterus of the mother at Beaufort, N. C., many years ago. In this Cæsarean operation the head was unfortunately torn off. However, there are left the pectorals, widely divergent from the head-stalk. Since this specimen was collected, I have gotten fairly complete sets of stages for other rays, and have personally found, what is of course well known, that in its development the baby ray "climbs its own

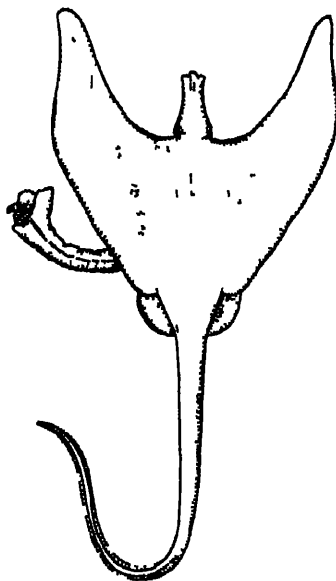


Fig 9 Larval form of sting-ray, *Dasyatis say*, in intermediate stage of development between shark and ray. The head is lacking but the fins have not yet grown fast to the head-stalk. The yolk-stalk is still present and is shown on the left.

ancestral tree," and in doing so goes through a number of shark stages. As the larval ray grows older, it becomes less shark-like and more like a ray, passing through the stages shown in figures 9 and 8. From this it is clear that the specimens of the barn-door skate described herein are cases of arrested development, of fixed larval forms, directly comparable to the perennibranchiate urodeles among amphibians.

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NEW FOSSIL MAMMALS FROM THE DEEP RIVER BEDS OF MONTANA

By W. D. MATTHEW¹ AND C. C. MOOK

PART I. OCCURRENCE

By C. C. Mook

The Deep River Beds of Montana were discovered by Grinnell and Dana in 1875, and named Deep Creek Beds. Later the names Deep River and Smith River were applied to the same series, and the name Deep River has been generally adopted. In 1878, Cope placed them stratigraphically as the base of the Loup Fork Beds. Later he placed them below the Loup Fork and above the John Day horizons, as understood at the time, and called them *Ticholeptus* Beds.

In 1893, Scott described additional material and recognized two distinct levels, an older one, equivalent to upper John Day, and an upper which was Cope's *Ticholeptus* Beds zone. E. Douglass in various contributions from 1899 to 1909 recognized the same division. In 1899, W. D. Matthew assigned part of the Deep River Beds to the lower part of the Upper Miocene.

The geological character of the country in which Deep River sediments and their included fossils are found necessitates great care in making correlations. The beds are exposed in isolated blocks along the Deep River, or Smith River, between White Sulphur Springs and Fort Logan, Montana. Exposures also occur south of White Sulphur Springs, some distance from the river. These isolated blocks are fault blocks. One may follow a creek bed through the Deep River sediments for a short distance in almost any direction and find a sharp fault contact with Palaeozoic or older rocks. The faults appear to extend across the country in several directions, and the faulting has broken the country up into a rough checker-board pattern. The vertical component of movement in a large series of blocks must necessarily have been unequal, and erosion operating after faulting would leave various stratigraphic levels at the same topographic level. As the Deep River Beds do not vary to any great extent lithologically in the vertical direction, great

¹Posthumous.

care must be exercised in comparing life zones in blocks whose nearness to each other and lithologic similarity might suggest exact correlation.

The specimens described by Doctor Matthew in Part II of this contribution were collected by Coleman S. Williams and C. C. Mook in 1925. They were found in a fault-block of Deep River sediments east of Smith River (Deep River) about seven miles southeast of Fort Logan, Montana. In the same block, within a few hundred yards of the specimens described, and at the same level, were found *Merychippus*, *Mookomys altifluminis*, *Merychys*, *Cyclopidius*?, *Dromomeryx*, *Alticamelus*, *Promerycochaerus*, and a number of other artiodactyls.

This fauna would indicate the upper rather than the lower of the two zones recognized by Scott and Douglass, but might be slightly higher or lower. In any case they may be considered as in the lower part of the Upper Miocene, or Middle Miocene.

PART II. DESCRIPTIONS

By W. D. MATTHEW

Brachyerix macrotis,¹ new species

TYPE.—Amer. Mus. No 21335, a skull from the Deep River Miocene of Montana. Collected by C. C. Mook and C. S. Williams, 1925, near Fort Logan, Montana.

DIAGNOSIS.—Two upper molars, M¹ quadrate, M² reduced and triangular. P⁴ with large, subtrigonal, nearly conical anteroexternal cusp, large crested internal heel and posteroexternal crest. P³ much reduced, small and simple, two-rooted, with longitudinally crested crown; two alveoli in front of P³ were probably for one small two-rooted premolar. Premaxilla unknown. Postpalatal region short, the basi-sphenoid expanded into a large nearly complete ossified bulla extending anteriorly considerably in advance of the articulation of the lower jaw, posteriorly covering over a corner of the basioccipital, while medially the two bullae are separated by a straight narrow channel continuous with the posterior narial gutter, which is much smaller and more constricted than in *Erinaceus*. From the posteroexternal angle of this bulla, a high continuous crest extends directly backward to the paroccipital process. This crest apparently represents the mastoid process, and the mastoid exposure is almost wholly lateral instead of being posterior as in *Erinaceus*. The occiput is rather strongly pitched forward, and the occipital crest well defined and continuous with the posterior wing only of the lambdoidal crest, the anterior wing being absent. The sagittal and postorbital crests are distinct but low. The lachrymal foramen is internal to the orbital rim in consequence of the prominence of the pre-lachrymal orbital crest. The infraorbital foramen lies close in advance of the orbit; its position is above P³, however, instead of above the anterior end of P⁴ as in *Erina-*

¹Derivation, *Spaxus*, short, -*erix* by analogy with *Galerix*, *Proterix* [the derivation of *Galerix* is obscure, possibly from some little-known Greek root connected with the Latin *ericus*, a hedgehog]. The species name refers to the large well-calcified bullae and inferentially well developed external ears.

ceus, owing to the shortened dentition in the present genus. The muzzle evidently much more slender and shorter than in *Erinaceus*, but the specimen lacks the premaxillæ and anterior part of nasals, so that its exact proportions are uncertain.

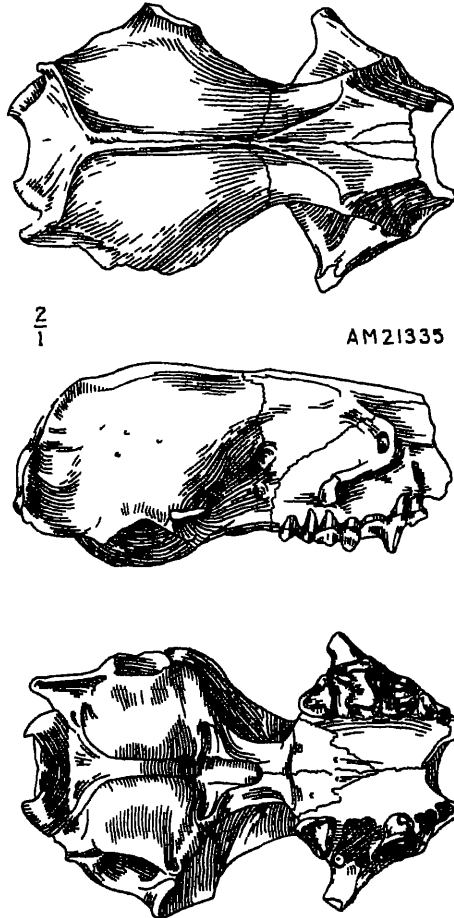


Fig. 1. *Brachyeriz montianus* Matthew, n sp.
Type, skull. Amer. Mus No. 21335. Twice
natural size.

Upper figure, superior view, middle figure, lateral view,
right side; lower figure, inferior view

The dentition differs from that of *Erinaceus* in the lack of hypocone on P⁴, reduction and trigonal form of M² and absence of M³. The skull characters also show wide differences and quite diverse specializations.

The skull of *Proterix* of the White River does not approach this one in any of the points indicated above; it is a pro-erinaceid, whereas the present genus is a para-erinaceid. None of the European genera are at all near it. *Dmylus* has the reduced number of molars, but the pattern of both molars and premolars differs widely. *Galerix* has three upper molars, and the pattern of the teeth is no nearer than in *Erinaceus*. *Neurogymnurus* also has three upper molars and the tooth pattern near that of *Erinaceus*. *Gymnura* and *Hylomys* show no special approach.

The family and ordinal position of this skull appear to be beyond doubt. It is sufficiently excluded from Chiroptera by the character of the bulla and other cranial features; from Carnivora by the bulla, the mastoid region, reduction of zygomata, character of lachrymal, proportions of teeth, etc.; from Primates by the teeth, zygomatic arch, occipital and various other cranial features. No suggestion of relationship to any other order, except Insectivora, appears in the specimen, and among Insectivora the only family that shows any helpful resemblances is Erinaceidæ. In this family it must represent a diversely specialized phylum, not primitive and synthetic as is *Proterix* (which combines characters of erinaceids and leptictids), but a special early side branch from the Erinaceinæ. It is somewhat remarkable that the two¹ known American erinaceids should each be represented by a single specimen and that a skull. No jaws or jaw fragments of either have ever been identified so far as I am aware.

Sciurus angusticeps, new species

TYPE.—Amer. Mus. No. 21336, a skull from the Deep River Miocene of Montana. Collected by C. C. Mook and C. S. Williams, 1925, near Fort Logan, Montana.

DIAGNOSIS.—Size of *S. aberti* but with narrower skull, smaller brain-case, smaller and somewhat narrower tympanic bullæ, upper teeth less transversely crested in pattern, zygoma narrower, the prezygomatic plate for the masseter less extensive either backward or forward, its posteroinferior border opposite P⁴ instead of M¹, while the crest that marks its anterosuperior margin is less prominent, and fades away before reaching the maxillo-premaxillary suture. Muzzle and incisors somewhat heavier than in *S. aberti*.

This skull, uncrushed and well preserved, is very instructive in that it provides definite evidence as to the relations of a Miocene squirrel to the various modern species of the genus *Sciurus* and its allies. It

¹Since Doctor Matthew wrote the manuscript of this article two other American erinaceids have been described. The four forms are.

Proterix loomvi Matthew, 1903, from the Upper Oligocene of South Dakota.

Metachinus nevadensis Matthew, 1929, from the Lower Pliocene of Nevada.

Metrix latidens Hall, 1929, from the Lower Pliocene of Nevada.

Brachyris macrotis, gen. and sp. nov., described above.

differs from modern squirrels very materially, but in characters that one might expect, *a priori*, of a primitive ancestral type. The brain-case is decidedly less developed, the peculiar sciuroid specialization of the masseter less advanced, the bulla smaller and more normal. These differences underlie a variety of other structural differences that may be seen in the drawings. The third premolar is fairly well developed, whereas it is minute or absent in some species of *Sciurus* and *Tamias*, but much enlarged in *Cynomys* and *Arctomys*. The Miocene species differs much more from the different species or subgeneric groups of *Sciurus* than they differ from each other. It compares on the whole more nearly with the large southwestern squirrels of which *Sciurus*

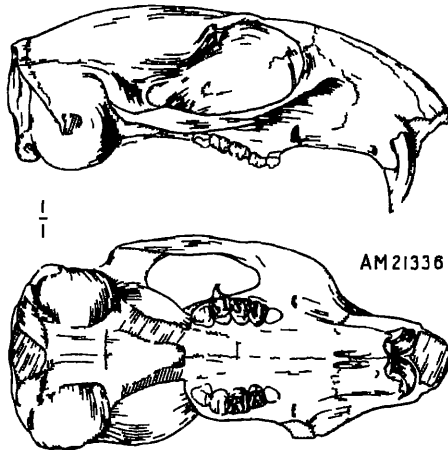


Fig 2. *Sciurus angusticeps* Matthew, n sp.
Type, skull Amer. Mus No 21336. Natural size.
Upper figure, lateral view, right side, lower figure,
inferior view

(*Otosciurus*) *aberti* is type. Yet it really affords no sound evidence for the view that it is ancestral to *Otosciurus* any more than to other groups of modern squirrels. It might just as well have given rise to various other groups or be the common ancestor of the whole genus.

It does not appear, therefore, that this finely preserved skull gives sufficient evidence to warrant its being placed in the subgenus *Otospermophilus*. Nor does it seem to be justifiable to place it in a separate subgenus or genus of its own. For the differential characters would be almost wholly of a primitive type, differences which would characterize the ancestors of every subgenus of *Sciurus* at a corresponding

stage of their phyletic evolution. As all the other subgenera represent end-stages of sub-phyla, a subgenus erected for *S. angusticeps* would represent something different in type, a mutation as opposed to a series of variations. It really calls for a different nomenclature, to be consistent, and rather than use a misleading term it is better to avoid any further nomenclative refinements and refer it simply to *Sciurus*.

If a well preserved skull does not provide adequate evidence for subgeneric reference, it is obvious that the much slighter evidence of a lower jaw is very far from adequate. Yet Doctor Merriam, following J. W. Gidley, has not hesitated to refer such a lower jaw from the Rattlesnake formation of Oregon, to the subgenus *Otospermophilus*. Such precise references of scanty material are little better than guesswork. They may serve to give a false impression of exact knowledge that does not really exist, and may be seriously misleading as to various larger problems. One would conclude that if one of the closely allied subgenera of *Sciurus* was already well distinguished at the end of the Miocene, the antiquity of the genus and of the family must be far greater, in due proportion to their structural diversity, and in fact Mr. Gidley's *a priori* views as to the great antiquity of rodent genera and species would receive strong support from this kind of evidence if it were really sound. But it is not sound, and the far better material herein described shows in this instance how utterly unreliable such scantily based evidence may be. I may add that thirty years of practical experience has convinced me reluctantly, that no amount of intensive study of fragmentary and insufficient material will discover in that material the sufficient evidence that is not there. One may by concentrated research discover mare's-nests aplenty, but true science is better advanced by going out and getting more and better evidence, and, until that is at hand, by refraining from conclusions that are not conclusively proved

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SKULL CHARACTERS OF *TELEORHINUS BROWNI* OSBORN¹

BY CHARLES C. MOOK

INTRODUCTORY REMARKS.—In 1903, several elongated crocodilian skulls and jaws, with some limb bones and vertebræ, were found by Mr. Barnum Brown in the region southeast of Pryor, Montana, and about thirty miles distant from that point. They occurred in Benton Shales of marine origin.

One of these skulls (Amer. Mus. No. 5851) was described by Osborn in 1904 as the type of *Teleorhinus browni*.² A considerable number of vertebræ and limb bones were associated with the skull.

The original generic description is as follows: "Cranium teleosauroid. Nasals continued forward to form roof border of anterior nares. Splenials prolonged into symphysis. Teeth compressed anteroposteriorly, uniformly grooved in front and behind." The portion of the specific description concerned with skull characters is as follows: "Forty maxillary and premaxillary teeth. Premaxillary teeth straight, maxillary teeth recurved.

"The skull (1000 mm.) and jaws (996 mm.) are preserved entire, with a larger number of the upper teeth. The skull in the upper view exhibits great breadth between the orbits, which are placed laterally. Large supratemporal fenestræ. Few sutures can be made out. The fronto-prefrontal elements connect anteriorly with the greatly elongated nasals which border the roof of the anterior nares."

In 1906, Williston discussed American amphiocelian crocodiles,³ and compared *Teleorhinus browni* with "*Steneosaurus*" *geoffroyi*, *Pholidosaurus* von Meyer, *Teleidosaurus* Deslongchamps, and *Hyposaurus* Owen. In 1925, Troxell described the characters of *Hyposaurus* in detail, and discussed the relations of this genus.⁴ Comparison of the characters of *Teleorhinus browni* with those of *Hyposaurus*, *Pelagosaurus* and *Teleidosaurus* clearly indicates generic distinction. The original description of *T. browni* by Osborn was brief and has never been followed

¹Contributions to the Osteology, Affinities, and Distribution of the Crocodilia. No. 24

²Osborn, H. F. 1904, '*Teleorhinus browni*—A Teleosaur in the Fort Benton,' Bull. Amer. Mus. Nat. Hist., XX, Art. 21, pp. 239-240

³Williston, S. W. 1906, 'American Amphiocelian Crocodiles,' Journ. Geol., XIV, pp. 1-17, 12 figs.

⁴Troxell, Edward L. 1925, 'Hyposaurus, a Marine Crocodilian,' Amer. Journ. Sci., Ser. 5, LX, pp. 489-514, 15 figs.

by a full description. The skull has been studied by the writer in connection with the preparation of a memoir on the crocodilian order as a whole, and many of the details of structure have been made out. These details are brought together in the present form because of necessary delay in the appearance of the complete memoir.

SKULL PROPORTIONS —The skull is exceedingly long and narrow. The snout, especially, is extremely long and slender. The length of the mid-line is over three times the breadth across the quadrates. The length of the snout along the mid-line is over four times its breadth at the base. The snout narrows rapidly from the base forward, and its sides converge forward only to a very slight extent throughout most of its length. The minimum breadth of the snout is immediately back of the posterior expansion; this minimum breadth is only one-sixteenth of the total length of the snout. The tip of the snout is somewhat expanded laterally, and is definitely turned downward. The cranial table is comparatively small.

SKULL OPENINGS —The foramen magnum was evidently small, but its outlines cannot be made out accurately owing to crushing of the bony elements surrounding it. The supratemporal fenestræ are large, but not excessively so. They are approximately equal in length and breadth, and are subquadrate in outline. The lower temporal arch is absent on each side; consequently the outlines of the lateral temporal fenestræ cannot be made out. The orbits are relatively small, and face upward, outward, and forward. Even before crushing it is unlikely that they faced directly outward as in *Pelagosaurus*. They are widely separated from each other. The external narial aperture is comparatively broad; it is situated on the anterior expansion of the snout, and is broader than the entire snout at the level of its minimum breadth. The aperture is subcircular in outline; it is protected anteriorly and laterally by up-turned flanges of the premaxillaries. The original description states that the nasals form the posterior borders of the aperture. This interpretation is not supported by the recent studies of this skull. The posterior border of the aperture appears to be composed of portions of the premaxillary bones.

On the palate there is no direct evidence of a small premaxillary foramen, but the region is incompletely preserved, and such a foramen may have been present. The palatine fenestræ are short antero-posteriorly. They extend forward past only four or five pairs of maxillary teeth. The posterior borders are incomplete, but broken edges of the pterygoids indicate that they probably did not extend very far back. The internal narial aperture and the bones surrounding it are not preserved.

SKULL BONES.—The sutures of the skull can be made out in only a few places; consequently a detailed description of each of the skull elements is impracticable. Some of the sutures can be made out, however, and other characters give clues to the identification of certain bones, so many of the bones may be described.

The nasals were stated in the original description to comprise part of the posterior border of the narial aperture. The adhering matrix has recently been cleaned from the anterior portion of the snout, and the relations of nasals and premaxillaries can now be made out with certainty. The posterior border of the narial aperture is composed of premaxillary bones and not of nasals. The nasals do, however, extend far forward and enter into contact with the premaxillaries.

The nasals are extremely long and slender. They extend forward to about the level of the sixth maxillary teeth. They extend forward along the mid-line for a distance slightly greater than two-thirds of the total length of the snout.

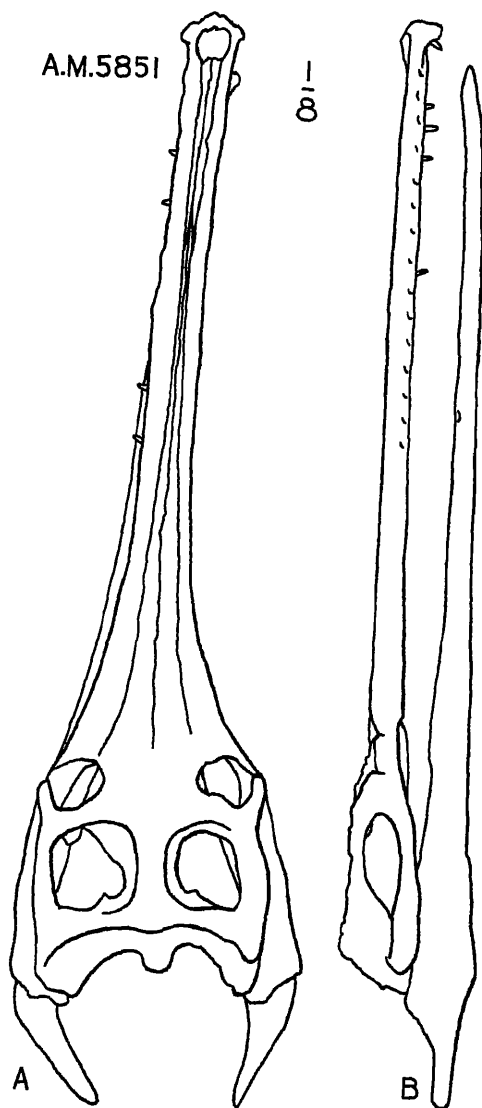


Fig. 1. *Teleorhinus browni* Osborn. Type specimen, skull and jaws (Amer. Mus. No. 5851). One-eighth natural size.
A, superior view; B, lateral view, left side.

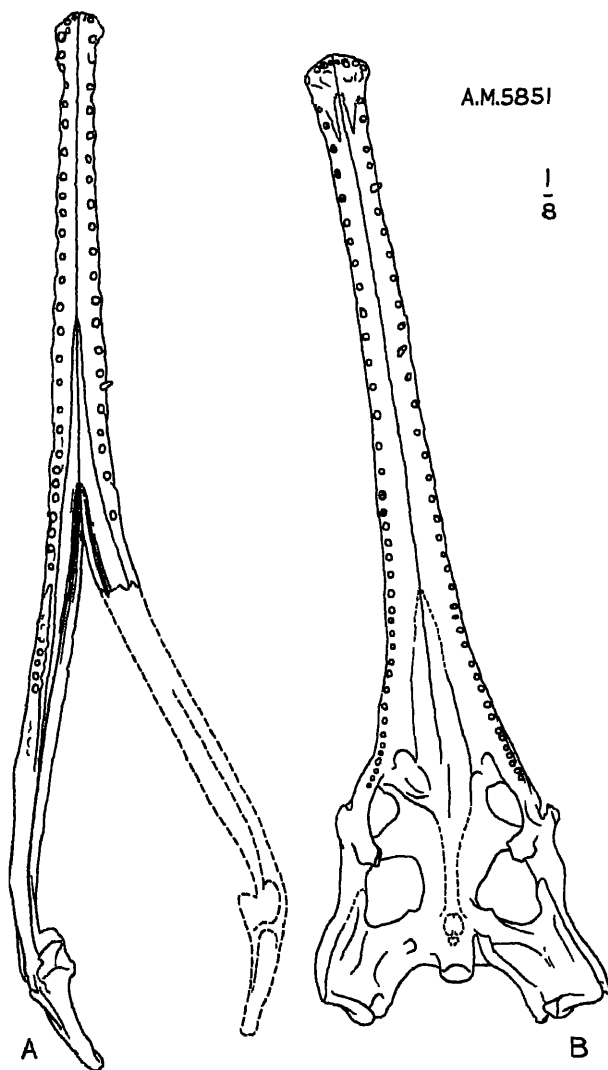


Fig. 2. *Telosorhinus browni* Osborn. Type specimen, skull and jaws (Amer. Mus. No. 5851). One-eighth natural size.

A, lower jaws, superior view, B, skull, inferior view.

The premaxillaries send back elongate posterior processes that overlap the nasals somewhat. They extend backward to a level midway between the seventh and eighth maxillary teeth. The overlap is about 33 millimeters in length, and for this distance the nasals are separated from the maxillaries by these processes of the premaxillaries. The premaxillaries surround the external narial aperture, and form the entire anterior expansion and downward projection of the snout.

On the palate the premaxillaries do not extend very far back, only to the level of the fourth maxillary teeth. The premaxillo-maxillary suture on the palate is simple in outline, the two premaxillaries forming a symmetrical wedge, with concave external borders, between the anterior ends of the maxillaries. Four alveoli are present in each maxillary. These are arranged in a slightly curved, but nearly transverse, row. The first three pairs depart very little from a direct transverse arrangement, but the fourth pair is slightly posterior and decidedly external to the others. The first, or median, alveoli are the smallest, the others are subequal in size.

Posterior to the second premaxillary teeth is a pair of deep pits which lodged mandibular teeth; a second pair of shallower pits lies external to the first pair, and a pair of external grooves is postero-external to these. There are no alveoli along the lateral borders of the premaxillaries; consequently there are diastemata between the premaxillary and the maxillary teeth.

Each maxillary appears to contain thirty-eight alveoli; it is possible that this number should be reduced to thirty-six, owing to the incompleteness of the alveolar borders at some points. The maxillary alveoli for the anterior three-fourths of the series are subequal in size, and are essentially equidistant from each other. The last eight or nine alveoli are smaller and closer together. All of the alveoli are complete in themselves, there being no suggestion of an alveolar groove. In the anterior portion of the series the distance from the center of one alveolus to the center of the next is equal to the height of a fully erupted tooth from base to tip. The alveoli indicate that the teeth were curved, and that they extended outward, forward and downward. Each alveolus is surrounded by a low crater-like wall, or rim.

The two maxillaries meet on the mid-line of the palate from the level of the fourth to the vicinity of the level of the twenty-second maxillary teeth. The anterior portions of the maxillo-palatine sutures are not distinctly preserved in the specimen, but they appear to meet at or near the level of the twenty-second maxillary teeth.

The region of the palatine and pterygoid bones is not well preserved in the specimen, making a clean-cut interpretation of this important region impossible. It is quite likely, however, that the internal narial aperture was situated rather far forward, perhaps between the posterior portions of the palatines.

MANDIBLE.—The mandible is long and slender. The symphyseal and post-symphyseal portions are about equal in length. The dentary bone occupies over two-thirds of the total length of each ramus. The jaw is extremely shallow vertically, and the tip is slightly expanded laterally. The symphysis extends back to about the level of the twenty-fourth mandibular teeth. The splenial comprises a considerable portion of the symphysis, extending forward to the level of the seventeenth mandibular teeth. The sides of the mandible are subparallel to the level of the seventeenth mandibular teeth; they then widen or diverge gradually to the level of the twenty-seventh teeth, just posterior to the symphysis. Back of this they diverge more rapidly.

The number of alveoli in each dentary is not clear, but appears to be thirty-eight. Each dentary has two small alveoli arranged transversely, at the tip, corresponding

in position with the three alveoli in the premaxillary. Posterior to these two alveoli, the alveoli are approximately equal in size and are arranged at approximately equal distances to the vicinity of the posterior end of the symphysis, back of which they are closer together and are smaller.

TEETH—A few teeth are preserved. They are slender, subcircular in outline, and decidedly curved. They extend downward, forward, and a little outward in the upper jaws, and upward, forward, and a little outward in the lower jaws. They did not extend outward in the manner exhibited in many specimens of European teleosaurs. The teeth are striated longitudinally with rather fine striae. None of the posterior teeth are preserved. The general adaptation implied by the form of the teeth is a fish-eating habit. The teeth, at least superficially, resemble those of many forms whose habits are known to be piscivorous.

CONCLUSIONS.—Although not closely related to *Teleosaurus*, *Steneosaurus*, or other typical Jurassic teleosaurians, *Teleorhinus browni* clearly has teleosauroid affinities. As pointed out by Troxell for *Hyposaurus*, it represents a survival of a primitive group, living along with the earlier forms of the procellos crocodilians. In Europe, the teleosaurs definitely disappear before the procellos forms appear on the scene. This survival involves a marine form, whose competitors were plesiosaurs and other marine reptiles, rather than river crocodilians.

MEASUREMENTS: —Length of skull along mid-line	960 mm.
“ “ “ including quadrates	1000
“ “ snout in front of orbits	750
Breadth across quadrates (restored)	310
“ “ posterior end of cranial table (restored)	242
“ “ orbits	242
“ “ posterior end of snout	177
“ “ tip of snout	67
“ “ snout, minimum	46
“ “ supratemporal fenestra	192
“ between supratemporal fenestra	22
“ “ orbits	95
Length of longest tooth preserved, external to alveolus	24
“ “ external narial aperture	34
Breadth of external nares	48
Length of cranial table	120
“ “ mandible	1065
“ “ symphysis at surface.	480
“ “ “ entire	538
Breadth at symphysis	75
“ minimum	37
“ maximum (distorted).	300
Ratio, total breadth of skull over median length	323
Ratio, breadth of snout at base over length of snout	236

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THE SKULL OF *DISSOPSALIS CARNIFEX* PILGRIM, A MIOCENE CREODONT FROM INDIA

By EDWIN H. COLBERT

The Creodonts are generally considered as typical of Eocene times, with occasional phylogenetic lines extending into the Oligocene period, when the entire suborder became virtually extinct. Discoveries made in the last score of years have shown us that two genera of creodonts, both of them belonging to the hyaenodont group, persisted into the Miocene period. One of these genera, *Metapterodon*, is from the diamond fields of South Africa, and its stratigraphic position shows that it barely survived the transition from Oligocene into Miocene times¹. The other genus, *Dissopsalis*, from the lower Siwalik beds of northern India, persisted well into the Miocene period, and consequently is the last known survivor of creodont evolution.

Dissopsalis was described by Pilgrim on the basis of some scattered and fragmentary teeth.² Subsequent to the description of his original material, no new finds came to light until 1922, when Mr. Barnum Brown of the American Museum obtained a skull and part of a mandible, as well as several scattered teeth, from the lower Siwalik beds of the northern Punjab States. These remains, hitherto undescribed, form the basis of the description in this paper. Further and more critical considerations of the genus will be presented in a subsequent work, which will comprise a detailed examination of the entire Siwalik fauna in the American Museum.

The drawings in this paper are by John C. Germann and Margaret Matthew.

Order Carnivora
Suborder Creodonta
Superfamily Pseudocreodi
Family Hyaenodontidae

¹Stromer, E. 1926. Reste Land- und Süßwasser-Bewohnender Wirbeltiere aus den Diamantfeldern Deutsch-Südwestafrikas. Sonderabdruck aus E. Kaiser, Die Diamantenwüste Südwestafrikas, Bd II, pp. 110-112, pl. 40, figs. 13, 14.

²Pilgrim, G. E. 1910. Notices of New Mammalian Genera and Species from the Tertiaries of India. Rec. Geol. Surv. India, Vol. XL, Pt. 1, p. 64. (*Dissopsalis carnifex*, *Dissopsalis ruber*.)

Pilgrim, G. E. 1914. Description of Teeth Referable to the Lower Siwalik Creodont Genus *Dissopsalis*, Pilgrim. Rec. Geol. Surv. India, Vol. XLIV, Pt. 4, pp. 265-279, pl. 29.

Dissopsalis carnifex Pilgrim

SPECIMENS IN THE AMERICAN MUSEUM —

Amer. Mus. 19401.—Skull, the palate and cheek dentation complete; rostrum anterior to P¹ missing; occipital portion shattered. Lower Siwaliks, 1600 feet above the level of Chinji Rest House, one mile north of Chinji Rest House, northern Punjab.

Amer. Mus. 19402.—Portion of a right maxilla, with P²-M³; also left P^{2,3}. Lower Siwaliks, at base. East of Chinji Rest House.

Amer. Mus. 19403.—Mandibular fragment, with left M₂₋₃. Lower Siwaliks, 100 feet above level of Chinji Rest House; four miles west of Chinji Rest House.

Amer. Mus. 19339.—Left M¹. Lower Siwaliks, about 600 feet above the base, one mile north of Chinji Rest House.

Amer. Mus. 19348.—Right P⁴. Lower Siwaliks, 1600 feet above level of Chinji Rest House; one mile north of Chinji Rest House.

Amer. Mus. 19349.—Left P⁴, right M². Lower Siwaliks, 1600 feet above level of Chinji Rest House; one mile north of Chinji Rest House.

DIAGNOSIS —

1. A fairly large hyaenodont, comparable in size to *Hyaenodon cruentus*.
2. Dentation: I ?, C, P 4/4, M 3/3, carnassial shear on M², M₃.
3. Premolars robust, with well developed cingula. P⁴ with a very large internal protocone.
4. Molars trenchant. M¹ and M² with large protocone, appressed paracone and metacone, and with a metastyle shear. M³ very small. Lower first and second molars with well developed trigonid and basined talonid. In M₃ the trigonid has become trenchant, while the talonid is reduced to a small tubercle.
5. Skull heavy. Frontals expanded above orbits, sagittal crest high, zygomatic arch long. Brain case constricted.
6. Palate wide, pterygoids produced posteriorly, almost reaching the glenoid articulation. Bullae presumably cartilaginous.

THE SKULL.—

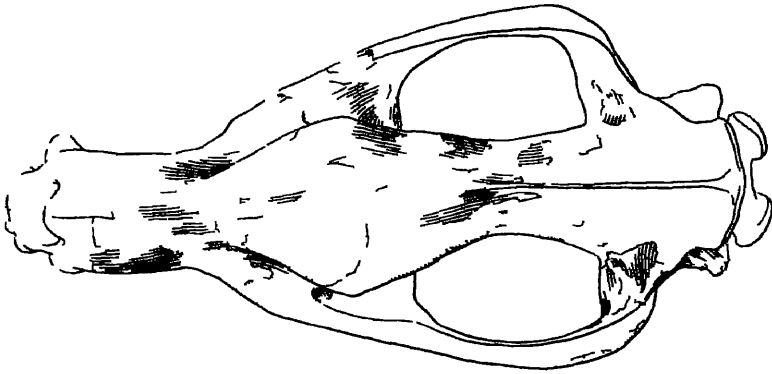
The skull, Amer. Mus. 19401, was discovered by a native, who unfortunately had no knowledge of the technique of fossil collecting. Consequently he damaged the specimen irreparably while removing it from the rock, so that what had been a perfect specimen, was reduced to a muzzle, containing the cheek teeth, a fragment of the cranium, two fragments of the zygoma, and numerous small scraps too badly broken to be readily identified. Mr. Brown collected fragments and impressions of the specimen, and from this material it has been restored, thanks especially to the efforts of Mr. Otto Falkenbach, with a fair approximation to the probable appearance of the original skull. In addition to the damage done by the native collector, the skull suffered a considerable amount of crushing, due to the weight of overlying sediments, so that the maxilla was broken, while the frontals and the nasals were pushed down on the sides of the face. By making careful measurements of the

crushed parts of the maxilla, and by calculating the amount of their displacement, and in addition, by the comparison of uncrushed skulls of related animals, such as *Hyaenodon* and *Cynohyaenodon*, it has been possible to restore the skull of *Dissopsalis* to approximately its original height. (Compare fig. 1 with the restoration, fig. 4)

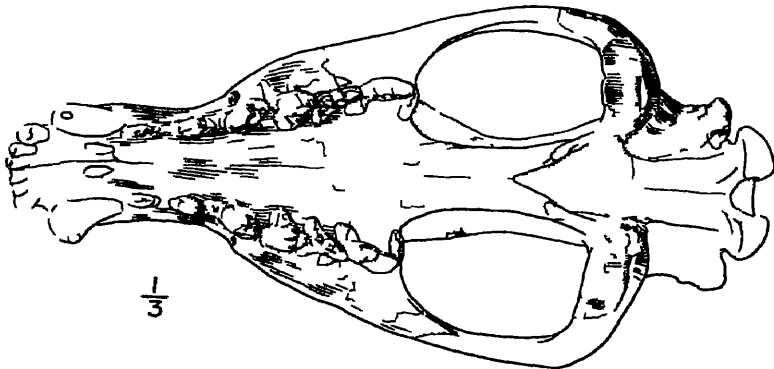
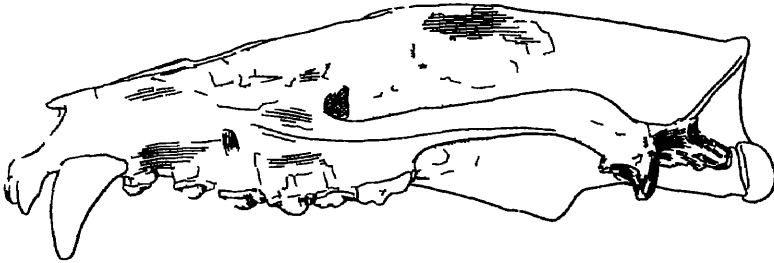
As to size and general form, the skull of *Dissopsalis* is quite similar to that of *Hyaenodon cruentus*. The skull of *Dissopsalis* is broad above the orbits, from which point it decreases in width rapidly, to the front and to the back. In this genus, as in other creodonts, the brain case is restricted. The narrowest portion of the muzzle is above the second premolar, while anteriorly the rostrum becomes wider to accommodate the canines. As seen from the side, the skull is fairly high. The infra-orbital foramen is above the mid-portion of the third premolar, and as in other hyaenodonts it is situated at some distance in front of the orbit. Due to the crushing down of the frontals, the anterior border of the orbit has been slightly displaced, but the configuration of the right side of the specimen would indicate that the front of the eye socket was above the anterior border of the second molar. The nasals are long, and would appear to extend forward, as in *Hyaenodon*.

The palate is constricted between the anterior premolars, but it widens rapidly posteriorly, reaching its greatest transverse dimension between the second molars. The incisor foramina are located between the canines, and would appear to be elongated. A core of matrix indicates that the pterygoids formed either a closed tube, as in *Hyaenodon*, or a long, narrow trough, as in *Sinopa*, *Cynohyaenodon* and other early genera. This tendency for the close approximation or the joining of the pterygoid borders, causing the posterior nasal choanæ to open far to the back of the palate, was characteristic of the hyaenodont group. It probably was not connected with any aquatic habits, since otherwise the skull indicates a typically terrestrial animal, but rather was developed for a support or a protection for the pharynx. A similar development of a "pterygoid tube" may be seen in the modern procyonids, such as *Nasua*.

The rest of the skull will hardly admit a detailed description. Suffice it to say that the sagittal crest is high, a corollary of the restricted brain case and strong temporal muscles. Evidently *Dissopsalis* (and this statement is borne out by the teeth) was able to crunch the bones of fairly large animals. The glenoid fossa of the squamosal is elongated transversely, with a strong post-glenoid process and a heavy anterior border. It is relatively large, an indication that the mandibular articulation was strong. On the left side of the skull a portion of the post-



A M 19401



$\frac{1}{3}$

Fig. 1.—*Dissopsalis carnyez* Pilgrim. Amer. Mus. No. 19401. Skull; dorsal view above, lateral view in the middle and ventral view below. One-third natural size.

The dotted areas represent matrix, which indicates the shape of the bone formerly covering these surfaces.

glenoid region is preserved, showing that the paroccipital process is situated far back, and that it does not project downward very much. The bullae, being cartilaginous, were destroyed at the time of fossilization.

THE DENTITION.—

Although the canines are missing, the skull fragment gives some slight indication of their probable size. That is to say, from the shape of the muzzle in front of the first premolar it would appear that the canines were rather strong and heavy.

The presence of the first premolar in the American Museum skull settles a point on which Pilgrim was doubtful, for this tooth was lacking in all of his material. It is a small tooth, elongated antero-posteriorly, with a single cone composing the crown, with slight cingula on the postero-internal and external surfaces, and with an incipient heel behind. It was seemingly almost in contact with the canine. A short diastema separates the second premolar from its predecessor. The second premolar which is larger than the tooth anterior to it, is surrounded by a cingulum; it consists of a large conical cusp, followed by a trenchant heel. The third premolar is relatively long, and in form is much like the preceding tooth. It is surrounded by a cingulum, which expands on the antero-internal corner to form a low cusp. The bulk of the tooth is composed of a large, conical and backwardly directed cusp, followed by a trenchant heel. The last premolar is quite different from the anterior teeth, for it possesses an extremely large and heavy internal protocone, which is of such size that it causes the transverse diameter of the tooth to equal, or even to slightly exceed, the antero-posterior measurement. The outer moiety of the tooth is similar to P².

The first molar is perfectly preserved in the skull, and it supplies more accurate information than hitherto known concerning this tooth. The protocone is considerably smaller than Pilgrim figured it,¹ and is connected to the outer portion of the tooth by two ridges, which terminate in two low cusps, the paracone and metacone. The paracone and metacone are distinct, but rather closely appressed, and there is a metastyle shear. An external cingulum is present.

The second molar, the principal upper carnassial tooth, is essentially an accentuation of the preceding tooth. The protocone is similar to that of M¹, the paracone is reduced, while the metacone is enlarged and the metastyle shear is elongated. In both M¹ and M² the outer cusps are

¹Pilgrim, G. E. 1914 op. cit., pl. 20, fig. 1

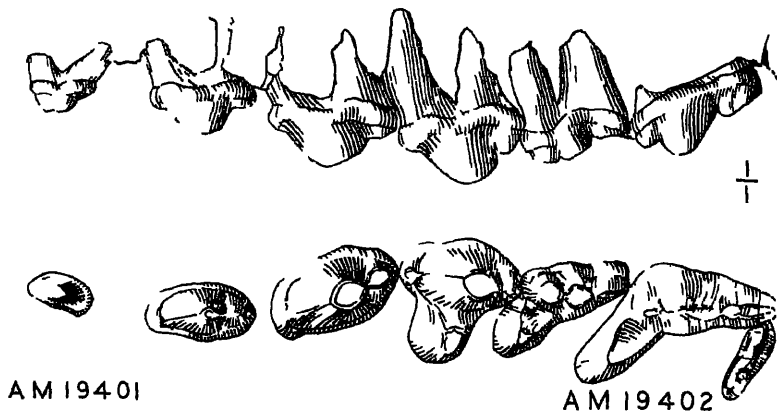


Fig. 2.—*Dissopsalis carnsfezi* Pilgrim. Amer. Mus. 19401. Right upper premolar and molar teeth. M^2 and M^3 drawn from Amer. Mus. 19402. Lateral view above, and crown view below. Natural size.

elevated above the protocone. The third molar, as seen in A. M. 19402, is a small tooth, considerably smaller than Pilgrim supposed from the fragments he studied. It is a shearing blade, set transversely to the axes of the carnassial blades.

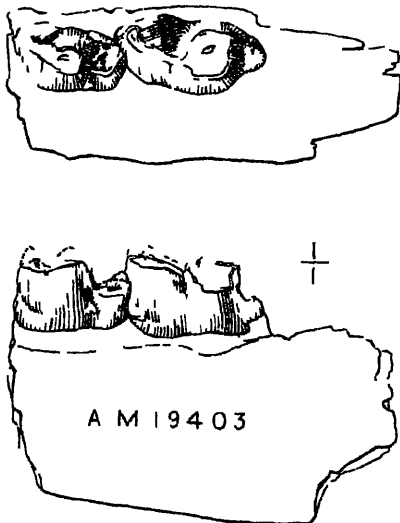


Fig. 3.—*Dissopsalis carnsfezi* Pilgrim. Amer. Mus. 19403. Left lower second and third molars. Crown view above, and lateral view below. Natural size.

In the mandible, the last premolar, as shown by Pilgrim, consists of a large conical cusp, probably the protoconid, followed by a trenchant heel. The first molar has a strong trigonid, consisting of the protoconid, paraconid and metaconid, and a basined talonid, of which the rim is formed by the hypoconid and entoconid. In the second molar the trigonid is high, the talonid is basin-shaped and relatively smaller than in M_1 . In the last molar the trigonid has developed into a large protoconid-paraconid shearing blade, and the talonid has been reduced to a small peg.

TABLE OF MEASUREMENTS

Amer Mus 19401					
P ¹	Anteroposterior diameter	9	mm	Transverse diameter	4 5 mm
P ²	"	"	14 5	"	" 8
P ³	"	"	18 5	"	" 10 5
P ⁴	"	"	17	"	" 17 5
M ¹	"	"	21	"	" 14
Amer Mus 19402					
M ²	"	"	23	"	" 13e
M ³	"	"	4	"	" 10
Amer Mus. 19403					
M ₂	"	"	20e	"	" 8 5
M ₃	"	"	20 5	"	" 9 5

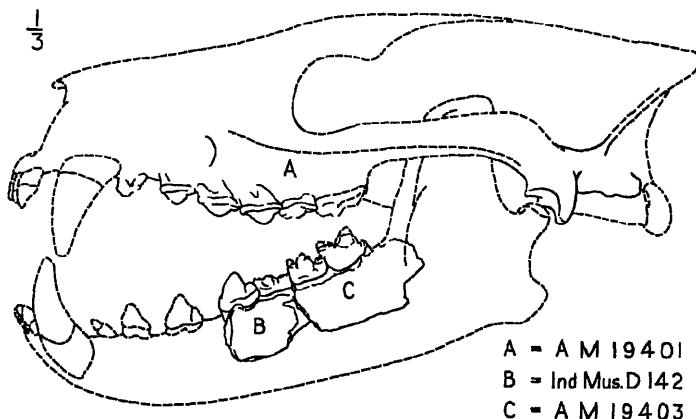


Fig 4.—*Dissopsalis carnifex* Pilgrim Restoration of skull and mandible, drawn from Amer Mus. 19401, 19403, and Indian Museum D 142 Lateral view, one-third natural size

The actual bone and tooth surfaces in place are represented by solid lines. The restored portions, drawn either from crushed bone or matrix, or from hypothetical inferences gained by a study of related genera, are indicated by dotted lines. This figure should be compared with figure 1, to see which portions of the skull were restored from bone and matrix, and which from hypothetical considerations.

AFFINITIES

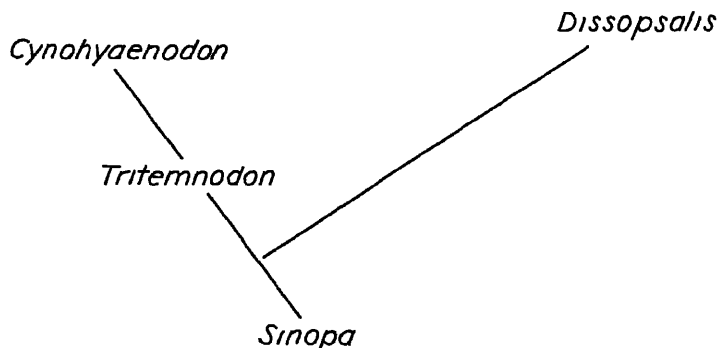
Dissopsalis, the last known survivor of the creodont line, is peculiarly primitive for such a long-persisting animal. Perhaps its very lack of specialization was a factor in enabling it to live until so late a date. Pilgrim has shown that *Dissopsalis* is clearly derivable from *Sinopa*, and

I think he is essentially correct in regarding the Siwalik genus as an independent phylogenetic line, closely related to *Cynohyaenodon* and *Querocytherium* of Europe.¹

Considering the skull of *Dissopsalis*, it would seem to have retained the primitive slender shape typical of the early hyænodonts, rather than to have taken on the robustness characteristic of the later genera.

In its dentition, *Dissopsalis* presents a curious mingling of primitive heritage characters and progressive habitus developments. A significant primitive feature in the upper molars is to be found in the relatively wide separation of the paracone and metacone, which presents a decided contrast to the condition in the advanced forms, where these cusps are closely appressed or fused. In addition, the *Dissopsalis* molars are primitive by virtue of the retention of a large protocone. Then again, the lower molars of *Dissopsalis* are primitive in that the trigonids are relatively low, while the talonids, except for that of the third molar, are comparatively large. Considering the advanced characters in the molar teeth of this genus, we see that the carnassial teeth have fairly well developed shearing blades which are disposed along fore and aft axes, causing the teeth to lose their original and primitive triangular outline. In addition to these progressive characters in the anterior molars, there may be mentioned the reduction in size of the last upper molar, and of the trigonid of the last lower molar.

Therefore, considering the mingling of primitive and advanced characters in the teeth of *Dissopsalis*, it would seem logical to suppose that this genus is actually representative of a separate phylogenetic line, having its origin in *Sinopa*.



¹Pilgrim, G. E. 1914. op cit., p. 276-7.

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THE PRESENCE OF TUBULIDENTATES IN THE MIDDLE SIWALIK BEDS OF NORTHERN INDIA

By EDWIN H. COLBERT

Among the fossils collected by Mr. Barnum Brown in the Siwalik series of northern India, during the season of 1922, are two specimens representing the order Tubulidentata. This discovery is of considerable importance, not only as an additional record of a rare fossil form, but also in that it establishes the Tubulidentates far to the east of their hitherto known range—a fact the significance of which will be brought out in the following paragraphs.

The material is fragmentary, as might be expected of a mammal so infrequently found in the fossiliferous state as are the aardvark. Both specimens are referable to the genus *Orycteropus*, and they seem to represent two species of almost contemporaneous geologic age. The one, a fragmentary maxilla with the last two molars, is a small species, retaining certain primitive characters; the other, a single molar tooth, represents a large form comparable to the Pliocene aardvarks of Greece and the Island of Samos.

The drawings in this paper are by Margaret Matthew. The four photomicrographs were taken by Dr. Philip Krieger of Columbia University.

Order Tubulidentata

Family Orycteropodidae

Orycteropus browni, new species¹

TYPE.—Amer. Mus. No. 29840, fragment of a maxilla, with LM^{2,3}.

HORIZON AND LOCALITY.—Middle Siwaliks, near base. One half mile south of Nathot, northern Punjab, India.

DIAGNOSIS.—*Orycteropus browni* is a small member of the genus, the teeth indicating it to be about three-fifths the size of *Orycteropus gaudryi*. The same approximate ratio holds between the Siwalik form and the modern *Orycteropus erikssoni* of Africa. The teeth are worn flat across the occlusal surface, as in the modern *Orycteropus*. The second molar is bilobed, and the vertical indentation between the columns is considerably greater on the buccal than on the lingual side of the tooth. The third molar is characterized by the extreme reduction of its posterior column, so that the tooth is little more than half the length of the molar preceding it. The teeth terminate below in open pulp cavities, as is characteristic of the genus.

*Named in honor of Mr. Barnum Brown of the American Museum.

The reduction of the posterior column in M^3 would apparently indicate an advance towards the modern type of *Orycteropus*. *O. gaudryi* from the Pontian (lower Pliocene) of Greece and Samos Island is typified by its strongly bicolumnar third molars. Consequently the Indian form, though fully as old geologically as *O. gaudryi*, would seem to show a modern specialization in the shape of its last molar. On the other hand, the microscopic structure of the tooth in *O. browni* shows some primitive traits. Evidently this species enjoyed a precocious development as to the form of the third molar, a development of degree rather than of kind, which did not extend to the fundamental micro-structure of the tooth.

Concerning the size of *O. browni*, I feel convinced that this animal was a small species (again an indication of its primitive nature) rather than a young individual or a local variant of a large species. The bone of the maxilla is that of an adult animal. Moreover, the discrepancy in size between this specimen and the large tooth, mentioned above, is much greater than that between young and adult, or between races of the modern African species.

TABLE OF MEASUREMENTS

	A. M. 29840 <i>O. browni</i>	A. M. 22978 <i>O. gaudryi</i>
M^2		
Length	7 7 mm.	10.2 mm.
Width	5 3	7.5
Height	10 0	
M^3		
Length	4 7	9 8
Width	4 7	6 7
Height	8 0	
Ratio, length of M^3 to M^2 $M^3/M^2 \times 100$	61	95

MICROSCOPIC STRUCTURE OF M^3

Longitudinal and cross sections were prepared from the second molar of *Orycteropus browni*, and similar sections from the homologous tooth in *Orycteropus gaudryi* were made, in an effort to determine, if possible, any structural peculiarities in the tooth of the new Siwalik species.

Cross Section.—The tubules are closely appressed, which has caused them to lose the original (hypothetical) circular section, thereby becoming irregularly poly-

gonal. Their shapes may be contrasted with tubules in the *O. gaudryi* molar, in which species these structures are more regularly hexagonal in cross section. In *O. browni* the tubules vary greatly in size throughout the diameter of the tooth, a condition similar to that found by Lönnberg¹ in a "supernumerary" tooth of *Orycteropus erikssoni*. On the other hand, the tubules in the molar of *O. gaudryi* show much less variation in size. Moreover, in this latter species, there is a regular gradation from large tubules around the periphery of the molar, to smaller tubules at the center of the tooth. In addition, the tubules in *O. gaudryi* are definitely elongated along their radial axes.

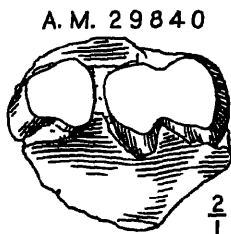


Fig. 1

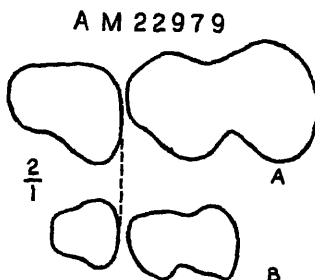


Fig. 2

Fig. 1. *Orycteropus browni*, new species. Type, Amer. Mus. No 29840. Crown view of right M^{2-3} in maxillary fragment. Twice natural size.

Fig. 2. Outlines of crowns of the right upper second and third molars in (A) *Orycteropus gaudryi* Forsyth Major, and in (B) *Orycteropus browni*, new species. Twice natural size.

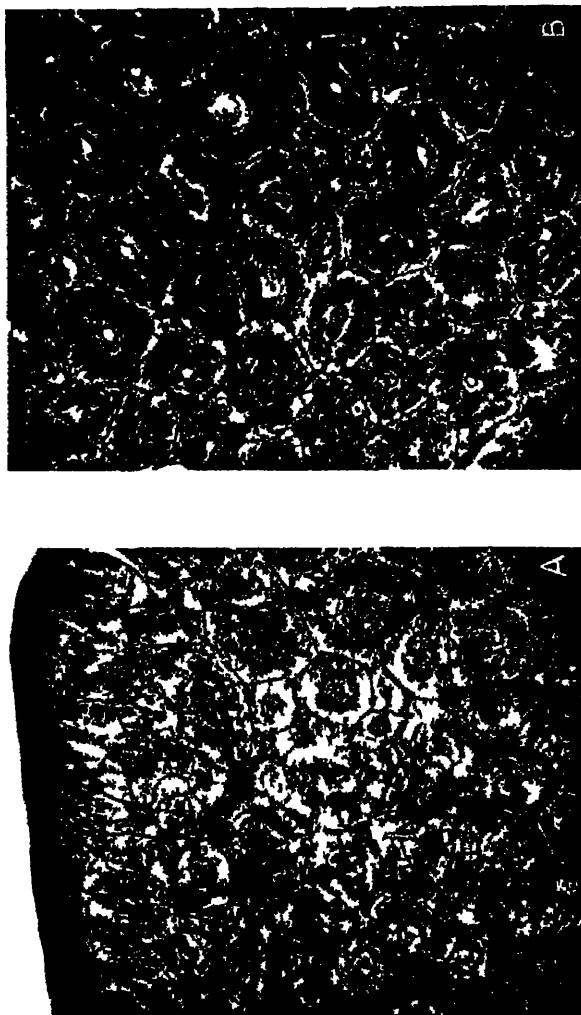
Thus it is seen that, in several characters, the molar of *Orycteropus browni* is structurally closer to a primitive tooth in the modern *Orycteropus* than it is to the molar of a Pliocene species. The described teeth of *O. browni* and *O. erikssoni* (the presumably primitive supernumerary tooth) are defined by:

1. Great irregularity in the shape of the tubules.
2. Considerable variation in the size of the tubules.
3. A size variation that ranges throughout the diameter of the tooth.

Orycteropus gaudryi must be considered as an advanced form, in that it demonstrates in the molar structure;

1. Regular hexagonal columns.
2. A definite gradation in the size of the tubules, from large ones around the outside of the tooth, to smaller ones in the center.

¹Lönnberg, Einar. 1905. Arkiv för Zool. Bd. 3, N 3, pp 24-25. The supernumerary teeth described by Lönnberg may represent either milk molars or teratological developments. If they are milk molars, which seems probable, they would show a type of structure somewhat more primitive than that of the permanent dentition.



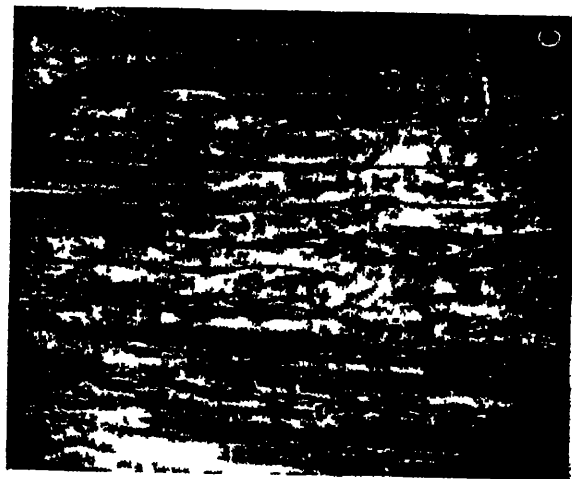
AM 29840

Fig. 3A

AM 22978

Fig. 3B

Fig. 3 Photomicrographs of cross sections of the right upper second molar in (A) *Orycteropus biowii*, new species, and in (B) *Orycteropus gaudryi* Forsyth Major. In A, a section of the thin band of cementum, which surrounds the tooth, is shown at the top and below are the irregular tubules characteristic of *O. biowii*. Section B shows the regular tubules characteristic of *O. gaudryi*. Both sections about forty times natural size.



A M 29840
Fig 4C



A M 22978
Fig 4D

Fig 4 Photomicrographs of longitudinal section of the right upper second molar in (C) *Oryzopsis browni*, new species, and in (D) *Oryzopsis gaudryi* Forsyth Major. Section C shows the branching and irregular tubules characteristic of *O. browni*; section D shows the parallel tubules of *O. gaudryi*. Both sections about forty times natural size.

As seen under a high magnification, the individual tubule in the *Orycteropus browni* molar consists of a hollow center, surrounded by a dentine column, in which the dentinal canals are radially arranged.

It should be added that there is an external band of cement shown in the cross section of the *Orycteropus browni* molar. A thin outer cement covering is a typical character of the *Orycteropus* tooth.

LONGITUDINAL SECTION.—In the molar of *Orycteropus browni*, the tubules are essentially parallel one to another, but a certain amount of branching is to be seen. This branching of the dentine tubules is a primitive feature, as proved by the structure of the supernumerary tooth described by Lönnberg,¹ and, more recently, by the molar of a Wind River (Eocene) tubulidentate described by Jepsen.²

In the molar of *Orycteropus gaudryi*, the tubules are strictly parallel, again an advanced character.

TABLE OF MEASUREMENTS

	A.M. 29840, <i>O. browni</i>	A.M. 22978, <i>O. gaudryi</i>
Radial diameter of tubules (average)	2/20–10/20 mm.	7/20 mm.
Tangential diameter of tubules (average)	2/20–5/20	5/20
Width of external cement band	2/20	

Orycteropus pilgrimi, new species³

TYPE.—AMER. MUS. 29997, a single tooth, identified as RM₂.

HORIZON AND LOCALITY.—Lower part of the Middle Siwaliks Four and one half miles west of Hasnot, northern Punjab, India.

DIAGNOSIS.—A tubulidentate comparable in size to *Orycteropus gaudryi*. In the form of the occlusal surface, the tooth differs from *O. gaudryi* by having straighter (that is, less rounded) anterior and posterior edges, and a slightly shallower groove on the lingual side between the anterior and posterior columns.

Of course it is questionable whether the slight differences outlined above are of sufficient value to establish this Siwalik tooth as a separate species. However, an examination of a number of specimens of *O. gaudryi*, shows that the occlusal shape of M₂ is constant, and that differences from the Siwalik tooth are readily recognizable. Moreover, it is quite likely that two terrestrial forms geographically separated by a distance as great as that between India and Greece, would belong to different species, even though they were contemporaneous in their geologic age.

¹Lönnberg, E. op cit., p. 29, fig. 10

²Jepsen, Glen. 1932. *Tubulodon taylori*, a Wind River Eocene Tubulidentate from Wyoming. Proc. Am. Phil. Soc., Vol. 71, No. 5, pp. 253–274

³Named in honor of Dr. Guy E. Pilgrim, for many years associated with the Geological Survey of India.

MICROSCOPIC STRUCTURE.—The tubules show quite plainly on the occlusal surface of the *O. pilgrimi* tooth, and on one side of the specimen a fracture reveals an excellent view of the tubules as seen longitudinally.

As to the microscopic structure, this species is very similar to *O. gaudryi*. The tubules are closely appressed, and rather regularly hexagonal, as in the Samos species. There is no great variation in size, the tubules averaging about $5/20$ mm. in diameter. Near the periphery of the tooth, the tubules are slightly elongated radially, and the diameters may reach $7/20$ mm. or $8/20$ mm. along the long axes. The hollow centers of the tubules seem to be slightly smaller than in *O. gaudryi*. The columns are strictly parallel.

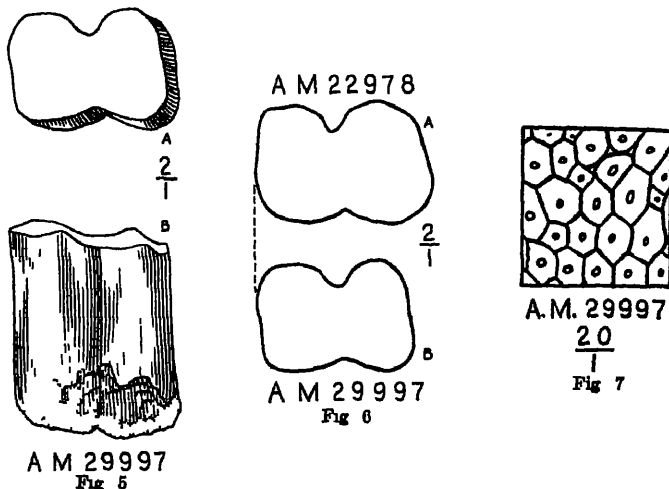


Fig. 5. *Orycteropus pilgrimi*, new species. Type, Amer Mus. No. 29997. A, crown view of right M_2 , anterior edge of tooth facing the left B, side view of lingual surface of the same, showing on the broken basal portion the parallel tubules. Twice natural size

Fig. 6. Outlines of crowns of the right second lower molar in (A) *Orycteropus gaudryi* Forsyth Major, and in (B) *Orycteropus pilgrimi*, new species. Twice natural size.

Fig. 7. Section of the occlusal surface of the right second lower molar of *Orycteropus pilgrimi*, new species, showing the rather regular, hexagonal tubules. Twenty times natural size.

DISTRIBUTION OF THE TUBULIDENTATES

The Siwalik species of *Orycteropus* establish the Tubulidentates far to the east of their previously known range of distribution in the Old World. According to our present knowledge, the occurrences of Tubulidentata are as follows.

<i>Orycteropus afer</i> (Pallas) and its several varieties	Recent	Africa
<i>Orycteropus capensis</i> , etc.		
<i>Plesiorycteropus madagascariensis</i> Filhol	Pleistocene	Madagascar
<i>Orycteropus gaudryi</i> Forsyth Major	Pliocene (Pontian)	Pikermi Samos
<i>Orycteropus pilgrimi</i> , new species	Pliocene or upper Miocene (Base of Middle Siwaliks)	Punjab, India
<i>Orycteropus browni</i> , new species	Pliocene or upper Miocene (Base of Middle Siwaliks)	Punjab, India
<i>Palaeorycteropus quercyi</i> Filhol (Based on an humerus; very doubtful)	Oligocene Quercy	France
<i>Tubulodon taylori</i> Jepsen	Eocene Wind River	Wyoming

If Jepsen's newly described form is really a tubulidentate, and I should think that his conclusions are correct on this point, it would seem that this peculiar order of mammals had its origin in North America, during the late Mesozoic or the Eocene. Consequently it migrated from thence, westward through Asia to Africa. *Tubulodon* appeared in the Eocene of Wyoming. Next, *Orycteropus* occurred in the upper Miocene or lower Pliocene of India, and almost simultaneously the order reached the Mediterranean region. Then in the Pleistocene, the order arrived in Madagascar, and finally, in recent times, it became distributed through south Africa. This is an example of a westward migration of an order, somewhat the opposite of the commonly postulated radial migration from central Asia, applied to so many groups of mammals.

Of course, the gap between *Tubulodon taylori* of the North American Eocene, and *Orycteropus browni* of the Siwalik lower Pliocene, is very great. If intermediate forms are to be found, they should be expected in eastern Asia. An Oligocene tubulidentate from Mongolia would complete the sequence, showing the migration of this order from the New to the Old World.

NOTE.—Jepsen's paper should be consulted for the latest views as to the ancestry of the tubulidentates. He would derive the order from some group of Mesozoic mammals, a view advocated by Broom, rather than linking it with the proto-ungulates, as was done by Sonntag and other authors.

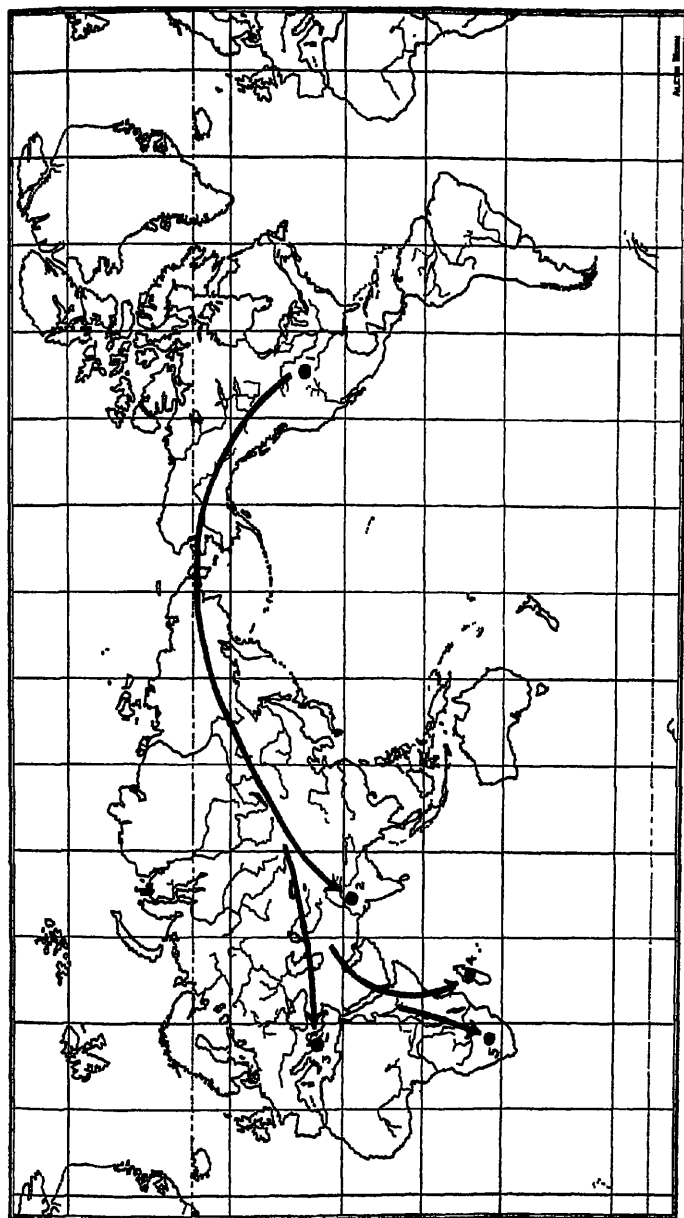


Fig 8. The probable migration routes of the Tubulidentata during Tertiary times. Key to figures on map

1. *Tubulodon taylori*. Wind River, Eocene. Wyoming
2. *Orycteropus browni*, *Orycteropus pilgrimi*. Lower portion of Middle Siwaliks, Miocene-Pliocene. India.
3. *Orycteropus gaudryi*. Pontian, Miocene-Pliocene. Samos Island.
4. *Plestorycteropus madagascariensis*. Pleistocene. Madagascar
5. *Orycteropus afer*, etc. Recent. South Africa.

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A NEW MUSTELID FROM THE LOWER SIWALIK BEDS OF NORTHERN INDIA

BY EDWIN H. COLBERT

The American Museum collection of Siwalik fossils, made in the northern Punjab of India by Mr. Barnum Brown, contains a small representation of carnivores, practically all of which belong to previously described genera and species. One fragmentary mandible is, however, of a new species of *Mustela* and it forms the subject of this paper.

Order Carnivora

Family Mustelidae

Mustela lydekkeri, new species¹

TYPE —Amer. Mus. No. 19407, a fragmentary mandible containing R and LM₁.

HORIZON AND LOCALITY —Lower Siwaliks, 200 feet above the level of Chinji Bungalow. Three miles west of Chinji Bungalow, northern Punjab, India.

DIAGNOSIS —A mustelid comparable in size to the modern *Charronia flavigula*. The lower carnassial is distinguished by its well developed metaconid, and the broad, basined talonid. The protoconid and paraconid form a shearing blade, the axis of which is but slightly inclined to the median axis of the tooth. The ramus is rather heavy, being slightly greater in depth than the length of the lower carnassial.

Except for size, *Mustela lydekkeri* is very much like *Mustela palaeosinensis*, described by Zdansky² from the Pliocene of China. In both forms the lower carnassial has a well developed metaconid, and a broad, basined talonid with a prominent inner rim. In *M. lydekkeri*, the metaconid is relatively larger than it is in the Chinese species, an indication of the slightly more primitive nature of the Siwalik form. The close correspondence between *M. lydekkeri* and *M. palaeosinensis* is well illustrated by the ratios of height to length, and of talonid length to total length in M₁, as given in the table below.

Charronia flavigula, the modern Indian marten, is seemingly nearest among living mustelids to *M. lydekkeri*. It differs from the fossil species mainly in the more reduced metaconid and the narrower talonid. The three species, mentioned above, are very close to one another, and *M.*

¹Named in honor of Richard Lydekker, who first mentioned this form.

²Zdansky, Otto. 1924. Jungtertiäre Carnivoren Chinas. Pal. Sinica, Ser. C, Vol. 2, Fas. 1, pp. 33-38.

palaeosinensis makes a good intermediate stage between *M. lydekkeri* and *C. flavigula*.

Lydekker¹ described in some detail a lower carnassial tooth in the Cautley collection, designating the specimen as *Mustela* sp., and comparing it with various Tertiary and recent species of the genus. He pointed out the close resemblance between the fossil specimen (B.M. No. 15914) and the recent *Mustela flavigula*, at the same time distinguishing the former from the latter by its larger metaconid and its wider talonid. His description fits perfectly the specimen in the American Museum collection, so it seems safe to assume that the single tooth that was under his observation is identical with the new species described here. It might be well to mention that neither an horizon nor a locality was given for the specimen described by Lydekker. Therefore it is permissible to assume that it came from beds of an age similar to those near Chinj Bungalow.

A part of Lydekker's description is quoted below.



AM 19407



Fig. 1. *Mustela lydekkeri*, new species. Fragment of left mandibular ramus, with first lower molar, and alveolus of second molar. A, crown view. B, side view. Natural size.

"In this specimen [B. M. No. 15914], which is represented in the accompanying woodcut (fig. 25), the form of the carnassial is precisely that of the corresponding tooth of *Mustela* proper, so that it may be safely referred to that genus. In size the two remaining teeth, as well as the ramus itself, agree almost exactly with the mandible of the living Indian *M. flavigula*; but the carnassial of the fossil is readily distinguished by the larger size of the inner cusp, and the greater development of the talon, which is relatively longer than in the existing species, being wider than any other part of the tooth. The inner portion of the talon has a distinct rim, which is wanting in the existing species, thus causing the talon to be slightly basin shaped.

These differences indicate that the Siwalik form is in all probability specifically distinct from *M. flavigula*. In the form of the carnassial and in general size the specimen is very close to *M. martes*; but the last premolar is considerably shorter than in that species. No other living species appears to come nearer to the fossil."

¹Lydekker, R. 1885. Cat. Foss. Mam. Brit. Mus., Pt. 1, pp. 177

TABLE

	<i>Plesictis palustris</i> A.M. 11001	<i>Mustela lydekkeri</i> A. M. 19407		<i>Mustela palaeosinensis</i> A.M. 26378	<i>Charronia flavigula</i> A.M. 84894
		R.	L		
Length of M ₁	7.3 mm.	9.9 mm.	9.4 mm.	13.3 mm.	9.7 mm.
Greatest width of M ₁	3.8	4.4	4.3	5.2	4.4
Height of protoconid	4.7	4.8	4.5	6.0	5.3
Height of metaconid	3.0	3.2	3.4	3.8	3.4
Length of talonid ¹	2.8	4.5	4.0	5.3	3.8
Depth of ramus below pr ^d	8.2	9.8	9.9	12.0	8.5
Ratio, height of pr ^d to length of M ₁	64	48	48	47	55
Ratio, length of talonid to length of M ₁	38	45	42	43	39

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¹Measured from the point of the metaconid to the back of the tooth.

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THE RELATIONSHIPS OF SOME COMMON AMPHIBIA AS DETERMINED BY SEROLOGICAL STUDY¹

BY ALAN BOYDEN AND G. K. NOBLE

It frequently happens in systematic zoology that after all the known facts on the anatomy, development, and distribution of a species have been brought together no definite conclusion can be reached as to the immediate relationships of a form. In the class Amphibia there are notable examples of this state of affairs. Among the salamanders, the mud-puppy, *Necturus*, represents such a case, and another is afforded by the eel-like *Siren* which has been well known in both anatomical and herpetological literature for over a century. There is one method of determining relationships that has not been applied to these or to the majority of the Amphibia: this is the precipitin reaction discovered in 1897 by R. Kraus (10²). Soon thereafter, it was applied to the study of animal proteins. Chiefly to Nuttall (18) belongs credit for the discovery that the intensity of the reaction is proportional to the degree of relationship of the species tested. The results of 16,000 precipitin tests, involving chiefly the Vertebrata, were described in Nuttall's book, 'Blood Immunity and Blood Relationship,' published in 1904. Recently one of us has devised new methods for the analysis of the precipitin tests on the sera of mammals (2). In the present study the tests have been applied to the Amphibia and especially to those salamanders whose relationships have remained in doubt. This work has involved the testing of other species of known relationship in order to secure a basis for comparison. Before turning to the tests a brief summary may be given of the relationships of these salamanders as at present understood.

THE SYSTEMATIC POSITION OF *SIREN* AND *PSEUDOBANCHUS*

The systematic relationships of the various families of salamanders have been summarized recently by one of us, in the form of a diagram (13). In only two of the eight families were the relationships so obscure that no connecting line of affinity could be drawn. The first of these

¹Contributions from the Zoological Laboratory, Rutgers University, and from the Laboratory of Experimental Biology, The American Museum of Natural History.

²See Bibliography, p. 24.

families, the Sirenidae, includes *Siren* and the related *Pseudobranchius*. These genera embrace three species of salamanders that retain throughout life most of the structural features of very young larvæ (13a). Oddly enough, the skin of *Siren* undergoes a metamorphosis typical of that of land salamanders. This metamorphosis may readily be induced by thyroid solutions (16). The chief difficulty in determining the relationships of *Siren* lies in the fact that most of the structural organization of this salamander remains that of a larva. Since the larvæ of salamanders are very much alike, few consistent family differences having been demonstrated, the number of clues as to the relationships of *Siren* is extremely limited. Moreover, the systematic value to be assigned to some of these characters frequently is a matter of opinion.

One of the most important clues as to the relationships of *Siren* apparently is found in the nasal region. Mesial to the dorsal spines of the premaxillaries there is found on either side a narrow splint of bone that has been homologized with the nasal of other salamanders. In the mature larva of *Hynobius chinensis*, as shown in our dissections, a part of the nasal bone forms a long splint mesial to the spine of the premaxillary very much as in the case of *Siren*. However, the nasal of *H. chinensis* has also a portion lateral to the premaxillary spine that is not found in *Siren* or *Pseudobranchius*. The two nasal bones of *Siren* and *Pseudobranchius* make contact in the midline. The only other salamanders in which the nasals meet without overlapping the premaxillary spines are the Hynobiidae and the derived Cryptobranchidae. In one plethodontid and in a few salamandrids, including the common newt, *Triturus viridescens*, the nasals make a contact by overlapping these spines. It might be argued that the condition in *Siren* and *Pseudobranchius* has been derived from that of these salamandrids by a loss of the lateral portions of the nasals. However, the premaxillary spines of *Siren* and *Pseudobranchius* are well separated and it would require less modification to derive the sirenid arrangement from that of *Hynobius*.

Siren and *Pseudobranchius* differ fundamentally from all hynobids and cryptobranchids in that the angular and prearticular are fused to form a single bone that shows no evidence of its duplex origin even in early stages of development. However, there is little evidence to show that the sirenids are related more to one than to another higher family. Reed (20) has considered that the sound transmitting apparatus of *Siren* resembles that of the newts more than it does that of other salamanders. Unfortunately the development of the otic apparatus of *Siren* is incompletely known. The palatoquadrato bar divides and the

posterior section undergoes degeneration at a time when the skin remains that of a typical larva. Hence it has been questioned as to whether this can be considered a metamorphosis of the palatal region homologous to that of caducibranchs (12). Whether or not the otic apparatus of *Siren* undergoes a transformation is not known, but the final form is very different from that of *Cryptobranchus* as described by Reed (*op. cit.*)

Recently the mode of life history has been found to shed light on the relationships of Amphibia (11). Neither *Siren* (15) nor *Pseudobranchius* (17) lay their eggs in the manner of hynobuds and cryptobranchids. They are deposited either in small groups or singly and not enclosed within the common envelope of jelly so characteristic of the Hynobudæ. Although the eggs resemble those of some newts more than they do those of any other salamander, the larvæ early develop horny mouth-plates, which have been compared with the prementary sheath of some larval hynobuds and ambystomids. The latter structure is not formed in any salamandrid. The sharp claws on the feet of the sirenids might be compared with the claws of the larval *Onychodactylus*, a hynobiid. The tips of the toes of other salamanders may be covered with horn, but this does not form the pointed claws like those of *Onychodactylus* and the sirenids. Again, the sirenids apparently practice external fertilization, to judge from the structure of their cloacæ, and this is found elsewhere among salamanders only in the hynobiids and cryptobranchids. However, it might be argued that the sirenids in most of their organization have not advanced beyond the condition of very young larvæ and hence the cloacal glands have been suppressed, although present in their immediate ancestors. The evidence of life history can not be considered as giving a decisive answer to the question of the relationships of the Sirenidæ. If one lays emphasis on the structure of the egg-mass the sirenids cannot be closely allied to the hynobuds. On the other hand the horny jaws, clawed toes, and external fertilization appear to indicate affinity to this group.

Although some of the distinctive features of the sirenids may be a consequence of a great increase in length, the majority represent a retention of larval structures. Thus the peculiar tail vertebrae have been commented upon (4). We find that the paired hæmapophyses resemble closely those of a young *Amphiuma*, 110 mm. in total length. The paired elements of *Amphiuma* and other salamanders have failed in *Siren* to differentiate beyond this early stage of development. The hyobranchial apparatus of the sirenids is obviously larval but it undergoes an early

ossification not found in caducibranchs. Similarly the hypertrophy of the Jacobson's organ does not occur in early larvæ of other salamanders.

To summarize, it may be said that while *Siren* and *Pseudobranchius* are obviously species that have failed to differentiate most of their structures beyond that of the early larval stage, they are peculiar in that a few structures in the same species are free from this developmental restriction. The skin of *Siren* undergoes a typical metamorphosis, while the palates of *Siren* and *Pseudobranchius* become modified in a manner resembling metamorphosis. Very few structures of the metamorphosed adult ever appear in the sirenids and hence these salamanders must be compared with the larvæ of other families. From the anatomical and life-history data available it is impossible to determine the nearest relatives of the sirenids. Arguments may be found for assuming either a hynobiid or a salamandrid ancestry. Moreover, neither the cryptobranchids nor the ambystomids can be ruled entirely out of the picture. It is very desirable, therefore, to attack the problem of the affinities of the Sirenidæ on some entirely new basis. The serological approach affords such a new angle of attack.

THE SYSTEMATIC POSITION OF *NECTURUS*

Necturus and its European relative *Proteus* have been separated from other salamanders as a distinct suborder, Proteida, not because of any marked structural difference but because they, like *Siren*, are larval types that fail to metamorphose and thus develop the characters usually employed in the identification of families. However, *Necturus* cannot be considered as great a puzzle as *Siren*, because it possesses the elaborate set of cloacal glands found in salamandrid, ambystomid, and all higher families. Like salamanders of these families it has the fused angular and prearticular. These features show that *Necturus* is a higher type than either the Hynobiidæ or the Cryptobranchidæ. The presence of lungs excludes it from close relationship with the Plethodontidæ. *Amphiuma*, the sole member of the Amphiumidæ, is too specialized in its elongate body and reduced hyobranchial apparatus to form the ancestral stock from which *Necturus* evolved. This leaves only the Salamandridæ and the Ambystomidæ among existing families in which to seek its relationships.

To be sure, Reed (20) found that the ear ossicles of *Necturus* showed a greater resemblance to those of Plethodontidæ and Amphiumidæ than to those of other families of salamanders. But these two families are specialized off-shoots of a salamandroid stock. The absence of horny

predentary plates in *Necturus* might be considered a salamandroid feature. *Necturus* lays its eggs attached singly to the under surface of stones or other submerged objects like some salamandrids and plethodontids do, but unlike any ambystomid. The Proteida agree with the Salamandridæ in being found today in both the Old and New World, while the Ambystomidæ are restricted to North America. The fossil record indicates that the salamandrids flourished in Europe from at least the Oligocene, but it gives no clue as to the origin of either *Necturus* or the ambystomids. Nevertheless, the anatomical and life-history data indicated above suggest that *Necturus* has closer affinities with the salamandrids than with the ambystomids. The existing evidence is by no means conclusive and consequently the new approach to the problem of relationships afforded by the serological tests should be of interest.

PREVIOUS SEROLOGICAL STUDIES ON AMPHIBIA

The literature of serological research on animals has recently been summarized by Erhardt (5). The Amphibia have received but little attention. Nuttall (18a) tested two weak anti-frog sera (against *Rana temporaria*) and found them to react only with *R. temporaria* and *R. ridibunda*.¹ Philippon (19) tested one weak anti-frog serum (against *R. esculenta*) which reacted only with *R. esculenta* and *R. temporaria* (cited by Nuttall).

These are all the precipitin investigations known to us that deal primarily with amphibian relationships. There are, however, two other studies involving precipitin tests with Amphibia that deal indirectly with the problem of relationships in this class of Vertebrata. The earliest of these is a study of Braus (3) in which it is reported that antisera against adult tissue extracts of *Bombina variegata* failed to react with tissue extracts of the larvæ of the same species. The conclusion drawn was that some important biochemical differences existed between the larval and adult stages of this species. Obviously such differences, if proved to exist, would be reflected in any serological classification of this species, for the larval and adult stages would be expected to react differently to antisera of other species.

The results of Braus have been flatly contradicted by Wilkoewitz and Ziegenspeck (21) who claim that they were unable to distinguish between the larval and adult stages of *Rana esculenta*. In other words there was complete identity, so far as the precipitin technique they employed could determine, in the larval and adult stages of this species.

¹Modern terminology for these species is used throughout this paper.

Of the two investigations the work of Wilkoewitz and Ziegenspeck is probably most nearly correct, though further refinements in precipitin technique may be able to disclose slight differences in serological reactions between the larval and adult stages of such organisms.

Wilkoewitz and Ziegenspeck further tested antisera against *Rana esculenta* larvæ and against *R. esculenta* adults with *Bufo bufo* and *Triturus* extracts and found them all to react very similarly. They also used a "Kunstserum" against *Bufo bufo* with the other Amphibia mentioned, with similar results.

These meager results indicate that the problem of the serological study of amphibian relationships has barely been touched. It has therefore seemed advisable to apply our tests to a number of Amphibia of known relationships before drawing conclusions as to the significance of our work with species of doubtful affinity.

PROCEDURE USED IN THIS STUDY

A.—PREPARATION OF THE ANTIGENS (BLOOD SERA)

The materials first needed in serological work are the proteins to be used in the production of antisera. In this study only blood sera have been so used. The species from which sufficient blood was obtained for the production of antisera are as follows:

Rana catesbeiana
Rana pipiens
Amphiuma means

Necturus maculosus
Cryptobranchus alleganiensis
Siren lacertina

These animals were bled from the heart, usually after slight ether anæsthesia. The anæsthetized animals were tied with their backs to a board. A slight cut was then made in the ventral body-wall exposing the heart, under the tip of which a centrifuge tube was placed. The animals were then placed vertically and the blood collected. It clotted quickly and was put in the ice-box overnight. The clot was then cut with a scalpel and the clear serum centrifuged off. This serum was then passed through sterile Seitz filters and bottled in sterile 5 ml. vaccine ampules with rubber stoppers. The last vial to be filled was left at a room temperature to test for contamination; the rest were stored in the ice box. If the test vial remained clear the serum was considered sterile.

In addition to the six species of Amphibia named above, from each of which 35 cc., or more, of serum were obtained, smaller amounts of serum were obtained from the following species:

Rana clamitans
Hyla septentrionalis
Ambystoma opacum

Desmognathus fuscus
Gymnophthalmus porphyriticus
Triturus viridescens
Plethodon glutinosus

There were thus available seven more species for titration. In the case of the last four species, the animals were bled after decapitation, the blood being wiped off on filter paper. While still wet this paper was cut in strips and extracted in 0.9 per cent sterile saline. After extraction overnight in the ice box the diluted serum was filtered, tested, and stored in the usual manner.

B.—PREPARATION OF THE ANTISERA

The first attempts at producing precipitin antisera in rabbits resulted in the death of the injected animals, due apparently to the inherent toxicity of the amphibian sera. In the next attempt fowls were used. Here, too, there were several fatalities until care was taken to get tough healthy cocks and to keep them in an outdoor pen during the course of the injections.

A common method of injection was followed. Each bird was given a series of increasing doses of one antigen, twice weekly, the first three or four injections being intraperitoneal, the following ones being intravenous (wing-veins). After five or six injections a rest period of seven days was allowed at the end of which time a small sample of blood (3-4 cc.) was withdrawn from a wing-vein for a preliminary titration. If this titration showed the antiserum to be too weak for use (titer of less than 3200) further injections were given, the first of these being small and intraperitoneal.

This second series of injections was often accompanied by symptoms of sickness on the part of the bird, diarrhoea, wobbling, weakness, and going to roost in midday, which in extreme cases led to prostration and death. Usually the bird recovered completely in the course of a half hour. After the last injection the bird was given a rest period of ten days, the last twenty-four hours being without food so as to clear the blood. It was then bled completely after decapitation, the blood being collected in a large pan. As soon as the blood had clotted it was cut in thin strips with a knife and these strips were put into flasks and placed in the ice-box overnight. The clear serum was poured off the clot and centrifuged. This antiserum was then passed through a sterile Seitz filter, bottled, tested, and stored in the same way as for the antigens. Eleven antisera were so prepared, their specificity as follows:

C ₄ , C ₅ , C ₈ , C ₉	anti- <i>Rana catesbeiana</i>
C ₁₈	anti- <i>R. pipiens</i>
C ₆ , C ₁₀	anti- <i>Amphiuma means</i>
C ₇	anti- <i>Necturus maculosus</i>
C ₁₂ , C ₁₄	anti- <i>Cryptobranchus alleganiensis</i>
C ₁₅	anti- <i>Siren lacertina</i>

C —MAKING THE TESTS

The general procedure in a serological study of biological relationships is to test each antiserum with the particular antigen used in its formation, and then follow with the testing of all the other available antigens. But it is of the first importance in comparative work that all the antigens used be OF THE SAME STRENGTH. This has been emphasized in previous work (1) dealing with Mammalia. In order to equalize the concentrations of the different antigens it was necessary to determine the protein nitrogen and calculate the content of protein with the usual factor 6.25. The method for determining the protein nitrogen was the Folin-Wright modification of the Macro-Kjeldahl (7). The results are given in Table I.

TABLE I —Protein content of amphibian sera

SPECIES	Protein in gms per 100 cc of serum or 100 cc of extract	
¹ A — <i>Rana catesbeiana</i> 7a	(serum)	2.66
<i>R. pipiens</i> a	(serum)	1.80
<i>Amphiuma means</i> 5b	(serum)	3.39
<i>Necturus maculosus</i> 1	(serum)	1.58
<i>Cryptobranchus alleganiensis</i> A	(serum)	2.56
<i>Siren lacertina</i>	(serum)	2.71
² B — <i>Rana clamitans</i>	(serum)	1.58
<i>Hyla septentrionalis</i>	(serum dil 1:50)	0.025
<i>Ambystoma opacum</i>	(serum dil 1:10)	0.25
<i>Plethodon glutinosus</i>	(extract)	0.013
<i>Desmognathus fuscus</i>	(extract)	0.094
<i>Gymnophthalmus porphyriticus</i>	(extract)	0.033
<i>Triturus viridescens</i>	(extract)	0.18

The values given in Table I are fairly consistent for the sera, but quite variable, as is to be expected, for the filter-paper extracts of whole blood. The B series of values is in excess of the true value of protein to the amount of the non-protein nitrogen present. The average amount of non-protein nitrogen present in the A series was 5.4 per cent. The quantities of antigen available in the B series were too small to allow the determination of the non-protein N, but the error due to this is probably insignificant in the secondary data based on the non-reciprocal tests in this series, which gave results to be accepted tentatively only.

In every case the dilution factor necessary to reduce the most concentrated sera to a standard dilution was calculated. The basic standard dilution chosen was a solution of 1 part of protein to 500 parts of

¹A Protein based on Total N minus non-protein N²B Protein based on Total N

saline. From this basic standard solution all higher dilutions were made. This procedure guarantees that all the corresponding dilutions of every antigen are truly comparable in their total protein content.

The series of antigen dilutions used is shown in Table II.

TABLE II.—Standard dilutions used in amphibian tests

Tube 1 = 1 part of protein to 500 parts saline	
Tube 2 = 1:1,000	Tube 8 = 1:64,000
Tube 3 = 1:2,000	Tube 9 = 1:128,000
Tube 4 = 1:4,000	Tube 10 = 1:256,000
Tube 5 = 1:8,000	Tube 11 = 1:512,000
Tube 6 = 1:16,000	Tube 12 = 1:1,024,000
Tube 7 = 1:32,000	Tube 13 = 1:2,048,000

Having determined the dilution factors to be used according to the strength of each available antigen in order to make the basic standard dilutions, one may begin to make the actual titrations. The procedure followed here was the usual ring-test procedure. A series of small clean test tubes of clear wall (heating to a glow in the gas flame clears and thins the wall) is arranged in a rack. Into each one except the first is pipetted 0.5 cc. sterile 1.8 per cent buffered saline of pH 7. The method of buffering was that of Evans (6). Then with a 1 ml. sterile pipette, 0.5 cc. of a 1:500 standard dilution of a particular antigen is put into tube 1 and a similar amount into tube 2. The contents of tube 2 are now thoroughly mixed by repeatedly drawing up the liquid and letting out of the pipette and then 0.5 cc. of the mixture (now 1:1000) is transferred to tube 3 where the mixing process is repeated. Thus each succeeding tube comes to possess half the concentration of the preceding one in the series. The last tube is given no antigen.

Into the bottom of each tube beginning with the last (which serves as a control) is carefully pipetted 0.1 cc. of the particular antiserum to be investigated. As soon as the series is finished the whole rack is placed in the water bath at 37.5°C. At 20, 40, and 60 minutes the reading rack is placed on a special reading stand so lighted that the zone of contact between antiserum and antigen is strongly illuminated. With the aid of a reading-glass the presence of a white layer of precipitate in the region of contact of antigen and antiserum may easily be observed. The precipitate is usually in a fairly thick layer in the tubes containing the lower dilutions and gradually thins out in the tubes of higher antigen dilutions. The last tube containing a distinct ring at the time of reading defines the titer or strength of the reaction. The readings at one hour were chosen for analysis in this investigation.

Experience with precipitating antisera obtained from both rabbits and fowls enables us to say that the fowl antisera are the most difficult to read. They tend to be slightly opalescent, though this may decrease on ripening in the ice-box over a period of several months. This opalescence is sometimes great enough to appear as a non-specific precipitation running through a whole series of dilutions and into the control. This appearance may sometimes be prevented by the use of the more concentrated saline (1.8 per cent) as suggested by Hektoen (9). But the real "specific" precipitation, whether homologous or heterologous, is usually sharp and clear-cut and hence readily distinguishable from the so-called non-specific precipitations. We have recorded as the titers of these tests only what appeared to be sharply defined distinct reactions and have disregarded the diffuse hazy appearance which is characteristic of the non-specific reactions.

One more matter should be explained before proceeding to the results of the tests. The relationship between any two species A and B is expressed in per cent. It is the ratio between the heterologous and homologous titers for those species. For example, suppose the homologous titer of antiserum A tested with serum A is 1:10,000; this is called 100 per cent. If the same antiserum tested with serum B gave a titer of 1:5000 the ratio of the heterologous and homologous titers is $\frac{1}{10000} \div \frac{1}{5000}$ or 50 per cent. The degree of relationship between species A and B is then 50 per cent or, more accurately, the blood proteins of the sera of these two species are 50 per cent similar as tested by this biological reaction. But now it has been pointed out (1) that the relationship between these two species can be determined not only in the above way but also in the contrary way, i.e., by testing antiserum B against serum B and serum A and comparing the heterologous and homologous titers again. Theoretically the two values should check within the limits of error of the tests if there are no disturbing factors, and hence the quantitative measure of the degree of relationship can be doubly checked.

Each test has been repeated one or more times and the variability in the successive readings indicates the amount of error involved. The error of reading is somewhat greater in this investigation than in the previous study of mammalian relationships mentioned above—due probably to the relatively greater opalescence of the antisera—and the reciprocal values do not check as closely as in the mammalian work. For the amphibian work one can only say that the reciprocal tests of the same two species are of the same order of magnitude.

THE PRIMARY DATA (RECIPROCAL TESTS)

Now let us proceed to the primary data resulting from the reciprocal tests. Table III gives the results of the reciprocal tests as tube numbers. By referring to Table II the actual titers in every test may quickly be determined. Note that the homologous titers are never exceeded by heterologous titers beyond the limits of error of the reaction. Note that the heterologous titers may sometimes be equal to the homologous titers, which indicates a close blood relationship. More often the heterologous titers are considerably less than the homologous titers. In some cases the heterologous reactions are very weak or negative, which indicates a remote degree of relationship. Note the general parallelism where two or more antisera of the same kind are tested with the other antigens. The reactions are all consistent enough, bearing in mind the errors involved in the tests, with one exception: this is the surprisingly high value of the C_{15} (anti-*Siren*) antiserum when tested with *R. pipiens* serum. A much lower reaction was expected in view of the weak reaction with *R. catesbeiana* serum. This marked difference in the behavior of the two *Rana* species is consistent with the relatively low value for the reciprocal tests between these two *Ranas* species, which indicates a not very close relationship. But let us not put too much emphasis upon such an unusual reaction; it cannot be fully explained at present.

To bring out more clearly the various degrees of relationships of these species to each other, the results have been calculated as per cents of the homologous titers, and these corresponding per cent values are given in Table IV. These per cent values are average values, based on all the titers of the repeated tests with the same antigen and antiserum.

Now, to get a final simple quantitative expression for the degree of relationship of these species, all the corresponding reciprocal per cent values for antisera and antigens of the same two kinds have been averaged and the probable errors of the resulting means (M) calculated. The results are given in Table V. Most of the M values are significant statistically. The exceptions are two of the *Siren* values: viz., *Rana pipiens* vs. *Siren lacertina*, and *Cryptobranchus alleganiensis* vs. *Siren lacertina*. These exceptional values are to be accepted subject to verification. As to the *Cryptobranchus-Siren* value, it is very low (2.61) and could not be much less than it actually is (0 being the lower limit). It might be somewhat greater, but not much greater without disturbing the other values whose reliability is more certain, and therefore we may accept it as being approximately correct.

TABLE III.—Results of the reciprocal tests given as tube numbers corresponding to the titers of the reactions. *a*, *b*, *c* are the three series of readings made. Series *a* was practically completed in June, 1931; series *b* in October, 1931; and series *c* in March, 1932. Homologous titers are italicized

Antisera	Antigens		<i>Rana</i> <i>calesbeana</i> 7a	<i>Rana</i> <i>pyrepis</i> a	<i>Amphiuma</i> <i>means</i> 5b	<i>Necturus</i> <i>maculosus</i> 1	<i>Cryptobranchius</i> <i>alleghaniensis</i> A	<i>Sven</i> <i>lacertina</i>
C ₄ <i>Rana</i> <i>calesbeana</i>	a b c 12 12 13	a b c 12 12 11	a b c 12 12 11	a b c 4 3 5 4	a b c 2 3 4	a b c 2 4 3	a b c 4 5 4	
C ₅ <i>Rana</i> <i>calesbeana</i>	13 12 12	11 12 11	3 1 2 3	3 2 3	2 3 3	3 3 3 4		
C ₆ <i>Rana</i> <i>calesbeana</i>	8 8 8	6 4 5	0 0 2	0 0 2	1 0 2	1 0 0		
C ₉ <i>Rana</i> <i>calesbeana</i>	10 11 11	9 10 11	1 3 1	2 3 2	0 2 1	2 3 2		

C ₁₆ <i>Rana</i> <i>pipiens</i>	8	7	6	13	10	10	10	2	0	3	3	2	3	0	0	0	0	1	0
C ₆ <i>Amphiuma</i> <i>means</i>	3	3	3	0	0	0	0	11	10	11	11	11	10	9	9	8	11	11	11
C ₁₀ <i>Amphiuma</i> <i>means</i>	3	3	3	2	1	3	3	13	11	12	12	12	10	10	11	10	11	12	13
C ₇ <i>Necturus</i> <i>maculosus</i>	2	1	1	2	2	3	3	10	9	10	13	13	14	10	11	10	13	13	13
C ₁₂ <i>Cryptobranchus</i> <i>alleganiensis</i>	3	3	4	2	3	3	3	8	9	8	11	11	11	13	13	13	7	5	5
C ₁₄ <i>Cryptobranchus</i> <i>alleganiensis</i>	3	2	3	5	2	4	4	4	5	3	9	9	9	10	11	12	4	5	5
C ₁₅ <i>Siren</i> <i>lacertina</i>	2	2	2	7	9	9	9	10	10	9	12	12	12	9	10	10	13	14	13

TABLE IV.—Results of the reciprocal tests given as per cent values corresponding to the titers of the reactions
The homologous reactions are recorded as 100 per cent and italicized

Antisera	Antigens	<i>Rana</i> <i>catesbeiana</i> 7a	<i>Rana</i> <i>pipiens</i> a	<i>Amphiuma</i> <i>means</i> 5b	<i>Necturus</i> <i>maculosus</i> 1	<i>Cryptobranchus</i> <i>alleganiensis</i> A	<i>Siren</i> <i>lacertina</i>
C ₁ <i>Rana</i> <i>catesbeiana</i>		100	62.5	0.33	0.17	0.15	0.39
C ₂ <i>Rana</i> <i>catesbeiana</i>		100	66.7	0.13	0.23	0.16	0.24
C ₃ <i>Rana</i> <i>catesbeiana</i>		100	14.6	0.52	0.52	0.78	0.26
C ₄ <i>Rana</i> <i>catesbeiana</i>		100	70.0	0.23	0.31	0.12	0.31
C _{1a} <i>Rana</i> <i>pipiens</i>		5.3	100	0.14	0.24	0.0	0.024

C ₆ <i>Amphiuma</i> <i>means</i>	0.44	0.0	100	95.2	23.8	114.3
C ₁₀ <i>Amphiuma</i> <i>means</i>	0.17	0.10	100	66.7	29.6	103.7
C ₇ <i>Necturus</i> <i>maculosus</i>	.024	0.05	7.8	100	12.5	75.0
C ₁₃ <i>Cryptobranchus</i> <i>alleganiensis</i>	0.13	0.08	4.16	25.0	100	0.008
C ₁₄ <i>Cryptobranchus</i> <i>alleganiensis</i>	0.17	0.45	1.13	13.3	100	0.007
C ₁₅ <i>Siren</i> <i>lacertina</i>	0.04	3.5	7.8	37.5	7.8	100

TABLE V.—Mean values of reciprocals and their probable errors

<i>Rana catesbeiana</i> × <i>Rana pipiens</i>	$= 43.82 \pm 8.4$
<i>Rana catesbeiana</i> × <i>Amphiuma means</i>	$= 0.30 \pm .039$
<i>Rana catesbeiana</i> × <i>Necturus maculosus</i>	$= 0.25 \pm .050$
<i>Rana catesbeiana</i> × <i>Cryptobranchus alleganiensis</i>	$= 0.25 \pm .065$
<i>Rana catesbeiana</i> × <i>Siren lacertina</i>	$= 0.249 \pm .035$
<i>Rana pipiens</i> × <i>Amphiuma means</i>	$= 0.121 \pm .01$
<i>Rana pipiens</i> × <i>Necturus maculosus</i>	$= 0.143 \pm .045$
<i>Rana pipiens</i> × <i>Cryptobranchus alleganiensis</i>	$= 0.266 \pm .088^1$
<i>Rana pipiens</i> × <i>Siren lacertina</i>	$= 1.77 \pm .82^2$
<i>Amphiuma means</i> × <i>Necturus maculosus</i>	$= 56.6 \pm 14.2$
<i>Amphiuma means</i> × <i>Cryptobranchus alleganiensis</i>	$= 14.67 \pm 4.12$
<i>Amphiuma means</i> × <i>Siren lacertina</i>	$= 75.3 \pm 18.6$
<i>Necturus maculosus</i> × <i>Cryptobranchus alleganiensis</i>	$= 16.94 \pm 2.22$
<i>Necturus maculosus</i> × <i>Siren lacertina</i>	$= 56.3 \pm 8.9$
<i>Cryptobranchus alleganiensis</i> × <i>Siren lacertina</i>	$= 2.61 \pm 1.43$

To express these quantitative measures of relationship graphically the following procedure is used (2). Since a high value for M means close relationship and this should be expressed graphically by a short distance between the species, it is a simple matter to take the value 100-M as the map or "tree" distance apart of the species. The values of 100-M for the species of Caudata tested reciprocally are given in Table VI.

TABLE VI.—100-M values for the Caudata tested reciprocally

<i>Amphiuma means</i> vs. <i>Necturus maculosus</i>	43.4
<i>Amphiuma means</i> vs. <i>Cryptobranchus alleganiensis</i>	85.3
<i>Amphiuma means</i> vs. <i>Siren lacertina</i>	24.7
<i>Necturus maculosus</i> vs. <i>Cryptobranchus alleganiensis</i>	83.1
<i>Necturus maculosus</i> vs. <i>Siren lacertina</i>	43.7
<i>Cryptobranchus alleganiensis</i> vs. <i>Siren lacertina</i>	97.4

When it came to locating the loci of these species on a "tree" expressing their present relationships, it was found that the values would not fit on a plane surface without breaking them into segments, but that they would fit very well in three dimensions, as was the case in the Mammalia (2). Taking *Cryptobranchus*, the most primitive form among the Caudata tested, as the starting point, the other species are located with reference to *Cryptobranchus* and to each other by their corresponding 100-M values. (Actually the values $\frac{100-M}{2}$ in centimeters were taken, simply to give a figure of convenient size.) A projection on to a plane surface of the caudate loci, with their corresponding tree distances, is shown in Figure 1a, and an actual photograph of the model itself is

¹Really not a reciprocal as the test can be calculated only one way.

²The *Siren* antiserum × *R. pipiens* antigen reaction was high, nearly as great as for the caudate antigens, but not so with *R. catesbeiana* antigen.

shown in Fig. 1b. These figures show, in a new way, the relationships of these Caudata. It may be of especial significance that the mathematical values for their interrelationship, based on quantitative precipitin tests, do fit together in a remarkable way. Furthermore, unless the relationship values are broken into segments, the old manner of expressing phylogenetic relationships on a plane surface will no longer suffice, for

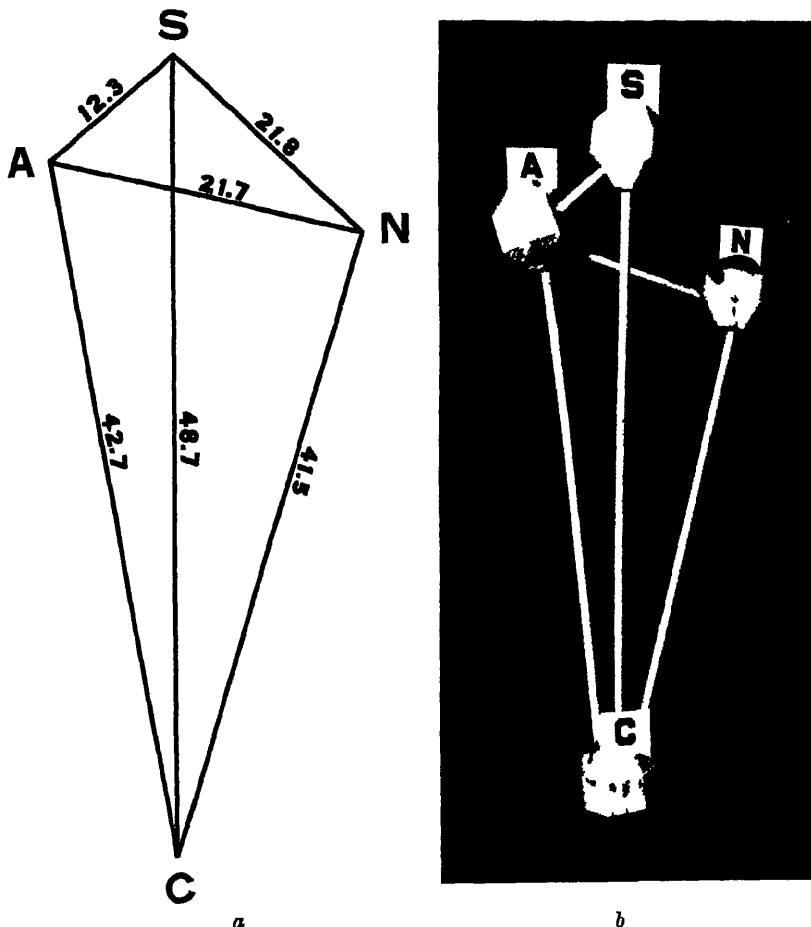


Fig. 1. The relationships of *Cryptobranchus* (C), *Amphiuma* (A), *Sphen* (S), and *Necturus* (N).

a. Projection onto a plane surface of the model pictured in b. The numerical values are the actual dimensions of the model in cm. equivalent to the $\frac{1}{100}$ relationship values.

b. Photograph of a model of the phylogenetic polyhedron of these salamanders.

these values will fit together only in three dimensions. May it not be of some unusual meaning that these values require three dimensions for their expression? Real trees grow in three dimensions, and this new method of picturing relationships seems therefore more natural than previous methods. The fact that this method is applicable to Mammalia also (2) suggests that it may be of some general significance.

The data shown in Tables III, IV, and V then give us a mathematical expression of the degrees of similarity in the blood proteins of the species studied. Insofar as similarity in blood proteins means genetic relationship, they may serve as a measure of the degree of present relationships among these forms. Considering especially the per cent values of Table IV and the reciprocals in Table V, it is seen that the relationship between Caudata and Salientia is very distant. On the other hand the Caudata all show definite relationships among themselves, and so do the Salientia.

As to the relation between *Rana catesbeiana* and *Rana pipiens*, it is (by the precipitin test) less close than the relation between *Amphiuma* and *Necturus*, or between *Amphiuma* and *Siren*, or between *Necturus* and *Siren*. These facts suggest that these two *Rana* species are not so close as to justify their being placed in the same genus. But it must be admitted that at the present time we have no anatomical basis for isolating them in separate genera. On the other hand, Hadley (8) describes a marked incompatibility of the skins of *Rana pipiens* and *Rana clamitans* in grafts. So far as this goes it suggests a lack of close relationship between these two species. This is what would be expected on the basis of the precipitin tests which put *Rana clamitans* and *R. catesbeiana* close together and both fairly distant from *R. pipiens*, and therefore to some degree supports the serological findings.

Our main problem, however, was to determine the mutual relations of the salamanders, especially those of the genera *Siren* and *Necturus*, whose exact systematic position has been long in doubt. *Cryptobranchus* is now known to be a large hynobiid salamander that normally metamorphoses its skin (14), but retains most of the organization of a larval or partly metamorphosed form. Because of its hynobiid affinities it may be placed with confidence at the base of our phylogenetic tree. It is of great interest that *Siren*, *Necturus*, and *Amphiuma* stand closer to one another than any one of them does to *Cryptobranchus*. *Siren*, which the anatomical evidence suggested was perhaps equally near hynobiids and salamandrids, is shown by the serological tests to be more remotely related to *Cryptobranchus* than is either *Necturus* or *Amphiuma*. We shall refer to the matter again after considering the secondary data.

No attempt was made to locate the Salientia on the "tree" because of their remoteness from all the Caudata tested. Nor were there reciprocal data sufficient to justify making a tree for the Salientia alone. Further work is indicated for these Amphibia.

It should be emphasized that the phylogenetic polyhedron shown is not a simple guide to ancestry. It does express PRESENT RELATIONSHIPS. It also suggests ancestry insofar as the base-form, *Cryptobranchus*, is really primitive, but it should not be interpreted literally as meaning that *Amphiuma*, *Necturus*, and *Siren* diverged from the *Cryptobranchus* we know today exactly along the lines connecting the loci of these species.

THE SECONDARY DATA (NON-RECIPROCAL TESTS)

These data were obtained for the species in which the tests could be made in only one way, because of the lack of sufficient antigen to serve for antiserum production. The results therefore lack the double check available for the primary data (reciprocal tests) and are to be considered tentative only. They are shown in Table VII as tube numbers and as per cent values.

The results shown in Table VII may be summarized briefly, the average degree of resemblance between each species and all the others in the series being as follows:

Rana catesbeiana 100 per cent; *Rana clamitans* 151 per cent; *Hyla* 2.7 per cent.
R. pipiens 100 per cent; *R. clamitans* 0.43 per cent; *Hyla* <0.57 per cent.

Amphiuma 100 per cent; *Triturus* 18.5 per cent; *Desmognathus* 7.3 per cent;
Gyrinophilus 1.4 per cent; *Plethodon* 1.24 per cent; *Hyla* 1.1 per cent; *R. clamitans* 0.57 per cent; *Ambystoma* 0.43 per cent.

Necturus 100 per cent; *Triturus* 9.4 per cent; *Plethodon*, *Ambystoma*, and *Hyla* 0.88 per cent; *Gyrinophilus* 0.43 per cent; *R. clamitans* 0.29 per cent; *Desmognathus* 0.15 per cent.

Cryptobranchus 100 per cent; *Triturus* 4.1 per cent; *Plethodon* 2.4 per cent; *Hyla* 0.60 per cent; *R. clamitans* 0.25 per cent; *Gyrinophilus*, *Desmognathus*, and *Ambystoma* 0.17 per cent.

Siren 100 per cent; *Triturus* 7.0 per cent; *Ambystoma* 1.8 per cent; *Plethodon* 0.88 per cent; *Desmognathus*, *R. clamitans*, and *Hyla* 0.44 per cent; *Gyrinophilus* 0.40 per cent.

The results indicate tentatively that *Rana catesbeiana* stands very close to *R. clamitans*,¹ and quite a distance from *Hyla*. On the other hand, *R. pipiens* is rather distantly related to both *R. clamitans* and *Hyla*.

¹The 240 per cent heterologous reaction between Cs and *R. clamitans* serum is an extreme error. The average value of all the tests between these two species is 151 per cent, which represents more clearly the error expected in the readings. It may be that although *R. catesbeiana* and *R. clamitans* sera were equal in total protein, the latter contained a larger proportion of serologically active protein.

TABLE VII.—The results of the non-reciprocal tests, the titers being indicated by the corresponding tube numbers and per cent values. Readings were made in two series, *a* and *b*, during May, 1932

Antisera Antigens	<i>Rana clamitans</i>		<i>Hyla septentrionalis</i>		<i>Ambystoma opacum</i>		<i>Gyrnophis porphyriticus</i>		<i>Triturus viridescens</i>		<i>Desmognathus fuscus</i>		<i>Plethodon glutinosus</i>	
	Tube	%	Tube	%	Tube	%	Tube	%	Tube	%	Tube	%	Tube	%
C ₄ <i>Rana catesbeiana</i>	<i>a</i>	12	8	4 7	—	—	—	—	—	—	—	—	—	—
	<i>b</i>	13												
C ₆ <i>Rana catesbeiana</i>	<i>a</i>	12	5	0 78	—	—	—	—	—	—	—	—	—	—
	<i>b</i>	12												
C ₆ <i>Rana catesbeiana</i>	<i>a</i>	12	5	1 9	—	—	—	—	—	—	—	—	—	—
	<i>b</i>	12												
C ₁₈ <i>Rana pipiens</i>	<i>a</i>	3	<4	<0.57	—	—	—	—	—	—	—	—	—	—
	<i>b</i>	4												

C ₆ <i>Amphiuma</i> <i>means</i>	a 3 b 3	0 45	<4 <4	<0 90	1 2	0 17	3600 3600	0 80	9 9	28 6	8 8	14 3	5 5	1 8
C ₁₀ <i>Amphiuma</i> <i>means</i>	a 5 b 5	0.70	6 6	1.4	5 5	0 69	28800 14400	1 96	9 8	8 3	4 4	0 35	5 5	0 70
C ₇ <i>Necturus</i> <i>maculosus</i>	a 5 b 5	0 29	7 6	0 88	6 7	0 89	7200 14400 14400	0 43	10 10	9 4	4 4	0 15	6 7	0 88
C ₁₂ <i>Cryptobranchus</i> <i>alleganiensis</i>	a 4 b 5	0 29	6 6	0 78	4 5	0 29	7200 3600	0 17	8 8	3 1	4 4	0 20	7 8	2 3
C ₁₄ <i>Cryptobranchus</i> <i>alleganiensis</i>	a 3 b 3	0 21	<4 <4	<0 42	0 2	0 05	<3600	<0 38	7 8	5 0	2 2	0 14	6 7	2 5
C ₁₅ <i>Siren</i> <i>lucertina</i>	a 5 b 6	0 44	5 6	0 44	7 8	1 76	7200 14400	0 39	9 10	7 0	6 5	0 44	6 7	0 88

As for the Caudata, *Necturus* is related to *Triturus* but distant from all the others. *Cryptobranchus* is quite distant from all of the Caudata tested. *Siren* is related to *Triturus* but distant from the others. These results on the whole are corroborative of the reciprocals in indicating that *Suen* stands fairly close to *Necturus* and *Amphiuma* but not to *Cryptobranchus*. *Triturus* seems to behave as a stem-form, bridging the gap between *Cryptobranchus* and the other species. *Triturus* is a primitive salamandrid and hence the serological tests lend strong support to one of the views expressed above, that on the basis of anatomical and life-history data both *Suen* and *Necturus* have sprung from a primitive salamandrid stock.

The reactions with the Salientia are all very weak and subject to great errors of reading, as are all weak reactions. The same is true for the Caudata with values under 2 per cent. Because of these greater errors and the lack of reciprocal checks, no significance is to be attached to the difference between the per cent values that are themselves under 2 per cent.

DISCUSSION

We have taken a problem in phylogeny that, though a considerable amount of anatomical and life-history data had been brought together, still remained unsolved. After examining the evidence both pro and con for the phylogenetic placing of the species, we have applied serological tests and have secured evidence of relationship to support one of the views. Neither *Siren* nor *Necturus* is a primitive salamander, but both are allied to *Amphiuma* and to *Triturus*. Very probably they represent an off-shoot from a salamandroid stock that made its way to America early in the Tertiary.

Nuttall showed conclusively that the precipitin reaction gave results that paralleled the systematic positions based on the older methods of phylogenetic investigation. With improvements in technique this test can now give a quantitative measure of present relationships, a measure whose reliability can be determined by the accepted biometric methods. We have then a means of studying present relationships independently of the older methods.

Already it appears that there are some important advantages in the serological method of attack. It is an objective test requiring a minimum of interpretation. It can become quantitative when carefully performed and its reliability determined by the usual methods. Moreover, there is the double check available in the reciprocal tests. Finally, it is likely

that the serological method is capable of differentiating forms whose structures are convergent, and of distinguishing at times between specialization toward simplicity in structure and real primitiveness

It is interesting also that the data from this investigation support previous work which led to a new type of graphical expression of phylogenetic relationships. viz , a three-dimensional "tree" or phylogenetic polyhedron. Surely a family tree, like any other, should grow in three dimensions

But this is just a beginning. Much additional work must be done before the final evaluation of the serological attack on problems of relationships and phylogeny can be made. In the case of *Siren* and *Necturus* it apparently has given us a satisfactory solution of a problem of long standing. In the case of *Rana*, further tests on some of the many other species in the genus are desirable before any final statement may be made as to number of subgroups that exist within this genus

CONCLUSIONS

The results of 300 precipitin tests on the blood sera of thirteen species of Amphibia are recorded quantitatively. The data suggest the following conclusions.

- 1.—The serological relationships of Caudata and Salientia are relatively remote.
- 2.—Within the Salientia, *Rana catesbeiana* and *Rana clamitans* are very close together, while *Rana pipiens* is not very closely related to either. *Hyla septentrionalis* is remote from all the species of *Rana*
- 3.—Within the Caudata, *Cryptobranchus*, an acknowledged primitive form, is not very closely related to *Siren*, nor to *Amphiuma* nor *Necturus*, the last three standing fairly close to each other.
- 4.—*Siren* and *Necturus* are related to *Triturus*. Apparently they both evolved from a salamandroid stock and not from the Hynobiidae, as some anatomical and life-history evidence indicated.
- 5.—Three dimensions are required to express graphically the present per cent relationships of the Caudata tested (unless the per cent values are broken into segments).
- 6.—The principle of reciprocal relationships generally holds to the extent that the per cent values of relationship of any two species are of the same order of magnitude, whichever way the test is made

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A PUG-HEADED GRUNT, *HAEMULON PLUMIERI*

By E. W. GUDGER

The members of the family Haemulidae, or grunters, so named because of the characteristic noise each fish makes with its air bladder, are among the most numerous marine percoid fishes on our south Atlantic and Gulf coasts. These fishes are among the most abundant of the food fishes found in Florida and throughout the Gulf-Caribbean waters, and are common in collections, being caught everywhere. The American Museum has the specimen figured and described herein (No. 2904), along with other representatives.

This example seems to be unique in that it is the only pug-headed *Haemulon* of which there is any record. Large numbers of pug-headed fishes, chiefly from the fresh waters of Europe and America, have been described. These fresh-water pug-heads come mainly from two groups: the salmonids sought by anglers, and their monstrous forms contributed to museums by them; the other group includes the carps and the carp-like forms, which are caught in large numbers by commercial fishermen, and pug-headed specimens brought into markets are often sent to museums for identification. Thus was obtained the first pug-head ever figured and described by a scientific man.

Rondelet, one of the fathers of ichthyology, in a book on fishes published at Lugduni (Lyons, France) in 1555, figured and described such a pug-headed carp, which he says he purchased at the fish market in Lyons. Rondelet's account, buried in his old book, I found years ago, and when opportunity presented itself I reproduced his figure and gave an account of his find to make known to teratologists this earliest figure.¹

Most of the marine pug-headed fishes reported belong to the sea-bass group. I have had and have described two such pug-heads² and in the same article I brought together accounts in the literature of such deformities in related fishes. To these records of salt-water pug-heads must now be added that of a *Haemulon*, a member of a group of marine fishes from which, so far as I know, no abnormality like this has ever been recorded. The history of this specimen follows.

¹Gudger, E. W., 1928 'Guillaume Rondelet's Pug-headed Carp: the Earliest Record,—A D. 1554' Nat. Hist., XXVIII, pp. 102-104, 2 text-figs.

²Gudger, E. W., 1930 'Pug-headedness in the Striped Sea Bass, *Morone saxatilis*, and in Other Related Fishes' Bull. Amer. Mus. Nat. Hist., LXXI, pp. 1-19, 3 Pls., 7 text-figs.

In the spring of 1910, the yacht 'Tekla' made a cruise in the waters of southern Florida. Mr. Alessandro Fabbri, the owner, invited Mr. John T. Nichols, of the department of fishes of the American Museum, for a cruise as a guest and particularly as a representative of the Museum. A number of interesting specimens were procured, but none more interesting than the one under consideration. At that time, there being no one at the Museum interested in such abnormalities, the fish was put away in storage and remained there until I began to publish articles on pug-headed fishes. Then our laboratory aid, Mr. Fred Kessler, remembered it and, to my great pleasure, brought it to my attention.

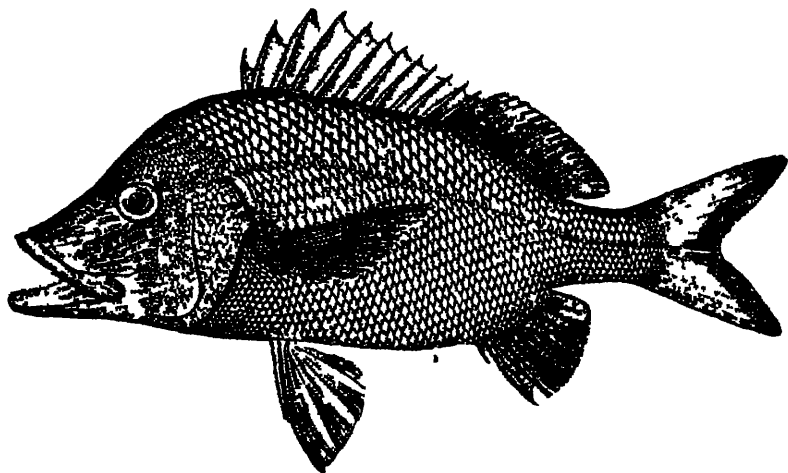


Fig 1. Lateral view of a normal common grunt, *Haemulon plumieri*. The open mouth fails to give a correct idea of the steep forehead in the normal fish.

After Jordan and Evermann, 1900

This specimen, which was taken in southern Florida in the spring of 1910, is a small fish only 218 mm. (6.8 in.) long over all, 75 mm. (3 in.) deep, and weighs 177 g. (6.25 oz.)—after being in preservative for nearly twenty-three years. It is, despite its small size, presumably mature. Examples of this species grow to a maximum size of eighteen inches and a weight of four pounds. However, specimens over two pounds are rare, and the average is said to be about one-third of a pound. The specimen under consideration is then of normal size and is adult.

It is a matter of interest to note that *Haemulon plumieri* ranges as far south as Brazil. Here was captured, figured, and described by George Marcgrave, that first great student of natural history in America,

a marine percoid fish which he called "Guabi coara Brasiliensibus" in his great book published in 1648.¹ This fish has been identified by the best authorities as the species of grunt under consideration. The present-day specific name was given to the fish by Lacépède, in 1802, by reason of a drawing of it sent to France from the island of Martinique by the Abbé Plumier.

The normal grunt, *Haemulon plumieri*, is a deep-bodied, short-nosed, steep-headed fish, in which the head is contained 2.5 to 2.8 in the body. These characters are very clearly shown in Figure 1, which is copied from the drawing reproduced in Jordan and Evermann's 'Fishes of North and Middle America' (1900, IV, Pl. ccv, fig. 532). Unfortunately the mouth is open and one cannot directly compare with it Figure 2, which is a drawing in lateral view of the pug-headed fish discussed in this paper. In the pug-head it is evident that the very marked shortening of the upper jaw has been accompanied with a very marked bulging of the forehead, directly in front of and on a level with the eyes. How great this bulging is may be seen by noting the distance from the nostrils forward to the rim of the forehead in Figures 1 and 2.

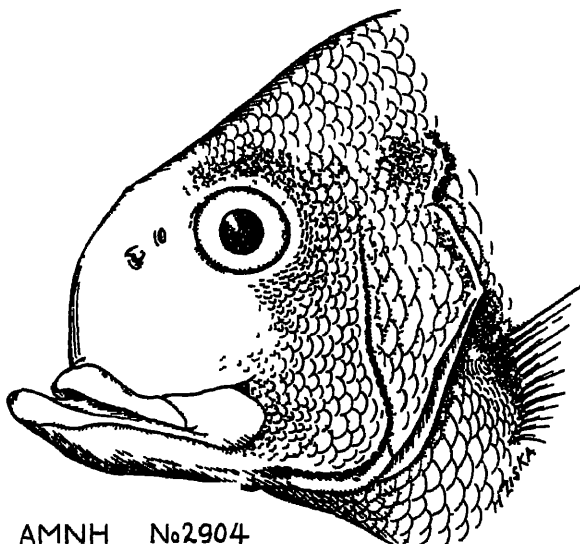
It has been difficult for me to divest myself of the idea that the lower jaw has also undergone shortening. However, the positions of the various structures of the head seem normal when compared with those in normal fish of the same species in our collection. Unfortunately our collection does not contain another specimen the exact size of the deformed fish, but comparative measurements lead to the conclusion that the lower jaw has undergone little if any shortening. This impression is strengthened when both fish are held in the position in which the deformed fish was held when Figure 3 was being drawn, and is further confirmed on opening the mouth and noting that in the abnormal fish the lower breathing valve is normally placed with regard to its distance from the point of the lower jaw.

Inspection of Figures 2 and 3 shows that the upper jaw is present in its entirety; in many pug-heads it is partly and frequently entirely lacking. Here it has been materially shortened, presumably in the central section, while the maxillary at the upper corner of the mouth seems entirely normal in shape and size. The flattened shape and cross-wise position of the remnant of the upper jaw are admirably shown in Figure 3, where the head is looked at from above. Below, and in front of the head, the projecting lower jaw may be seen. The lower jaw

¹'Georgii Maregravi Historiæ Rerum Naturalium Brasiliæ,' Amstelodami, 1648. (Guabi coara Brasiliensibus, p. 163, woodcut)

projects 7 mm beyond the cross-bar position of the upper. The projection in this view looks considerably greater than it does in Figure 1, but dividers show that both figures are accurately drawn. This cross-bar-shaped and -placed upper jaw is almost identical with what I found in the two specimens of *Roccus lineatus* described, as may be seen in Figure 4

There is, then, in this specimen, a marked shortening of the head in the upper jaw region accompanied by a noticeable bulging in front of

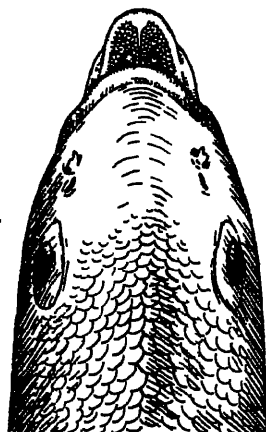


AMNH No 2904

Fig. 2

Fig. 2. Lateral view of the head only of a pug-headed common grunt, *Haemulon plumieri*, from southern Florida.

Drawn from specimen No 2904 in the American Museum.



AMNH No 2904

Fig 3

Fig. 3. Dorsal view of the head of the abnormal grunt in the American Museum. Note the continuous upper and the projecting lower jaw.

eyes and nostrils. The front of the head has undergone a marked shortening in the center, at the point of union of the premaxillaries. This shortening of the premaxillaries has brought about a crowding of the teeth into two roundish pads which hang, as it were, from a bulge or shelf in the upper mouth. The distance from the point of the upper jaw to the hinder or free edge of the upper breathing valve is less than in the normal fish. Apparently, however, the shortening of the head has carried the breathing valve backward somewhat.

Pug-headedness in *Haemulon plumieri*, as in similar teratological specimens of fishes, is due to the failure of the parasphenoid, or basal bone of the skull, to elongate. In many specimens, as in the sea-bass previously referred to, the parasphenoid buckles up into the space between the eyes and causes a marked exophthalmia. Whether or not such a bulging of the eyes was visible in this specimen when fresh cannot be said, but in this fish, preserved for so long a time, the eyes are sunken, and I judge that they were never very prominent. It seems probable that in this fish the buckling of the parasphenoid (if such is present) has resulted in crowding the nasals, preorbitals, and ethmoids forward to produce the markedly outstanding forehead. How this buckling may produce bulging of the eyes may be seen in the eyes of the pug-headed sea-bass shown in Figure 4.

What causes the parasphenoid to behave in this fashion in fishes cannot definitely be said, but it is known that pituitary disturbances in mammals produce shortening of the head and face—and give rise to pug-headedness in dogs. No experimental work has been done on fishes, but at least one pug-headed trout embryo has been described; and, since all fish embryos are at first short-snouted, it would seem that pug-headedness in fishes may arise as a germinal defect. There is here an interesting if difficult field for investigation.

Neither in Dean's 'Bibliography of Fishes,' nor in the classified card catalogue continuing it since 1914, is there any reference to this type of deformity in this group of marine percoid fishes. It has been de-



Fig. 4. Dorsal view of the anterior body-parts of a pug-headed sea-bass, *Roccus lineatus*. Here the same conditions found in the head of the grunt shown in Figure 3 may be seen, save that the eyes are protruding.

After Gudger, 1930

scribed, however, in specimens of the related genera *Labrax* and *Roccus*, as noted above, and Mr. John T. Nichols, my colleague, tells me that he once saw a round-headed silver perch, *Bairdiella chrysura*, taken in Florida. This specimen is at present preserved in the collections of the Museum, and I purpose to describe it shortly

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STRUCTURE AND AFFINITIES OF *TRIGONOSTYLOPS*¹

BY GEORGE GAYLORD SIMPSON

Trigonostylops is one of the most interesting and peculiar but has been one of the least known of South American mammals. Like most mammals of its age, from the *Notostylops* Beds, it was known only from parts of the dentition, which showed that it is very distinctive but gave little real idea of its general character or affinities. *Trigonostylops* was first described (Ameghino 1897, p. 492) from four imperfect and incorrectly associated teeth. Ameghino later (1901, p. 390) limited the name to a natural genus and recognized its principal dental characters. In all he named thirteen species (the majority of which are undoubtedly synonymous), the types all very imperfect and mostly single teeth. Tournouër found better material, enabling Gaudry (1904, figs. 14, 24, 36) to figure most of the upper and lower dentition. Roth (1899, p. 386) found a good lower jaw, but he did not figure it, and his description is cursory and not very enlightening. He did not recognize its resemblance to, or identity with, *Trigonostylops* and called it *Staurodon* (preoccupied, later replaced by *Chadon* Berg). The genus was one of the less abundant elements in the *Notostylops* fauna,² and that is the extent of previous knowledge of it.

To this is now added a skull nearly complete and with preservation unusually favorable for study, making *Trigonostylops* one of the best known, rather than among the least known, of early South American mammals. It proves to be even more peculiar than was anticipated, and indeed is one of the most extraordinary mammalian skulls ever discovered, being unusual in almost every detail and having some striking characters otherwise quite unknown in the Class Mammalia.

MORPHOLOGY

The following description of the morphology of the genus is based on the Ameghino Collection, numerous other isolated teeth and imperfect specimens, and the literature, but chiefly on these three excellent specimens:

¹Publications of the Searratt Patagonian Expedition, No. 12.

²About fifty specimens (mostly single teeth) are known to me, and the collections in Paris and Munich probably contain a few more.

- Museo de La Plata No. 12-1736. Symphysis and most of left lower jaw. Type of *Chadon* [= *Trigonostylops*] *gegenbauri* (Roth). Collected by Roth north of Lago Musters. Studied through the kindness of Drs. Torres and Cabrera.
- Field Mus. No. P13323. Lower jaw with left C_1 P_1 , and P_3 - M_1 and right P_3 - M_3 . Collected by the First Marshall Field Paleontological Expedition to Argentina and Bolivia, E. S. Riggs, leader, near Punta Casamayor. Studied by arrangement with the Field Museum of Natural History.
- Amer. Mus. No. 28700. Skull nearly complete except for most of rostrum, with P^2 - M^3 of both sides. Collected by Justino Hernández of the Scarritt Patagonian Expedition, south of Lago Colhué-Huapi.

The only significant points still unknown in the dentition, skull, and jaws are premaxillæ, nasals, upper incisors, and whether the enlarged teeth are canines, as they appear to be, or lateral incisors, as is possible.

DENTITION.—The premaxillæ are unknown, and no isolated teeth can be recognized as upper incisors of this genus. The upper incisors may have been absent. There are isolated tusk-like teeth in the collections which undoubtedly belong in the upper jaw of *Trigonostylops*. These are relatively large, moderately curved teeth with long, closed roots. The crown doubtless was enamel-covered, but the known specimens are all worn to the dentine and the actual crown pattern is unknown. There are two wear facets, both strongly oblique to the tooth axis and probably nearly vertical in life, the larger on the anterior, more convex, side, and the other contiguous but at an angle of about 225° to this, on the anterointernal side of the tooth. From the relationship of these wear surfaces to the lower tusks, it appears that these teeth probably pointed well forward, were widely separated at the alveoli, but converged slightly at the tips.

It has been assumed that the tusks are canines in *Trigonostylops*. The evidence, all inconclusive, is chiefly that they are morphologically more like some canine tusks than like most incisive tusks, that the opposite upper tusks were apparently widely separated at the alveoli, and that they somewhat resemble astrapothere tusks. The last, probably the real reason why they have been so identified, is the least conclusive reason of all, as the resemblance is not an identity and as the reasoning seems to have been that these were canines because they were like astrapothere canines and that the animal is related to the astrapotheres because its canines are similar. Opposed to their being canines are the facts that they are extremely anterior, at least in the lower jaw, and that there are only two pairs of lower incisors between them. Yet it does seem probable that they are really canines.

Gaudry's figure shows a single alveolus for P^1 near the middle of the diastema. Our specimen stops just where this alveolus should be and

does not show it, although it was very probably present immediately anterior to the parts preserved. There is no known upper jaw of the same provenience as Roth's lower jaw, which has no P_1 . Probably P^1 also was sometimes absent.

$P^{2,4}$ are apparently always present and are contiguous. P^2 is a small tooth, longer than wide, with a single main cusp, keeled antero-posteriorly. On our skull and some isolated specimens it has an internal basal swelling, not cuspidate, but this is absent in Gaudry's figure. $P^{2,4}$ have about the same structure and proportions, but P^4 is larger. The ectoloph has distinct paracone, metacone, and metastyle, united nearly to the apices but distinguished by individual convex vertical folds on the outer surface. Paracone and metacone are nearly equal, parastyle considerably smaller but prominent and separated by a sharp deep fold from the paracone, and metastyle still smaller and much less sharply distinguished, sometimes hardly visible especially on worn teeth. The whole inner side of the tooth is formed by the crescentic protocone, which is lower than the ectoloph. A low but sharp ridge runs from it to the junction of parastyle and paracone, and another, rounded and even less prominent but sometimes bearing a very feeble metaconule, runs to the base of the metacone. There are anterior and posterior cingula, the posterior usually slightly wider but not cuspidate. These are sometimes continuous across the inner face. A weak external cingulum may also be present.

The molars are not very different from the premolars but differ in their considerably greater length, anteroposteriorly, in proportion to the width, and in a number of structural details. The ectoloph is more prolonged posterior to the paracone fold and the region between this and the metacone fold is not a vertical groove but a rather broad flattened surface. The metacone fold is less prominent. Paracone and metacone are of about equal height on M^1 , but the metacone is somewhat smaller on M^2 and definitely smaller on M^3 . The crest from the protocone to the parastyle-paracone junction has no protoconule and is sharp and definite, although low, but the crest from protocone to metacone is very feeble or hardly present as such, although a small metaconule of varying prominence is always present. The anterior cingulum is well developed. It sometimes crosses the inner face of the protocone, but never runs directly into the posterior cingulum, but at most abuts against the base of the elevated internal end of the latter. The posterior cingulum is wider than the anterior, and its inner end, directly posterior to the protocone, rises to form a small ridged or cingulum-like hypocone, of varying

development but always much smaller and lower than the primary cusps and excluded from the trigon basin. This basin is shallow and broad, with a rounded, featureless bottom. An external cingulum is generally present, at least between paracone and metacone folds, and may give rise to basal cuspules (as in Ameghino's *T. germinalis*).

M³ is not reduced in size, and it is difficult or impossible surely to distinguish the position of isolated upper molars. Tooth replacement in this genus seems to be normal, rather than much delayed as it very commonly is in notoungulates. In our specimen M³ is fully formed but not erupted, M² in place but little worn, M¹ more worn, and all the permanent premolars in place and normally worn—premolar replacement followed the eruption of M¹ but is complete before the eruption of M³.

The enamel is finely wrinkled on all the cheek teeth, upper and lower.

The lower incisors are known only from Gaudry's figure. He shows two pairs of equal size, each with the crown consisting of a simple rounded lobe.

The lower tusks, presumably canines, have long but closed roots. Upon emerging from the alveolus, the tooth curves sharply outward and upward. The crown is enameled and more or less caniniform, a curved cone modified by an anterior keel. Roth's specimen preserves both canines. The roots are strongly appressed in the symphysis but are about 45 mm. apart at the tips, which point outward, upward, and backward. On this specimen each canine has a groove, the bottom enamel-coated and hence not due to wear, in the anteroexternal face. This is not visible in the other specimens seen by me, but may have been removed by wear in them. In these teeth there are generally two wear facets, a small one truncating the tip nearly at right angles, and a much larger facet on the posterior side nearly parallel to the long axis of the tooth. It is interesting that on Roth's specimen the right canine is much more worn than the left.

Ameghino (1901, p 391) says that "la première molaire [i. e. P₁] d'en haut et d'en bas, toujours très petite, varie d'emplacement selon les espèces; elle se trouve placée tantôt contre la canine et séparée de la suivante par une barre; et tantôt contre la deuxième, la barre se trouvant alors entre la canine et la première molaire [P₁]." Unless it was based on specimens unknown to me and not now in the Ameghino or other collections examined, this statement rests on no good evidence and is probably not true. In Roth's specimen P₁ is lacking altogether, and this may

have been true of some of Ameghino's own specimens, although they are too imperfect for certainty on this point. In Gaudry's figures and on the Field Museum specimen, P_1 is a vestigial tooth in the middle of the diastema. On the latter, and apparently also the former, it is one-rooted and has one low, blunt cusp with an anteroposterior keel, followed by an incipient heel.

P_2 is sometimes smaller than the following teeth, but is two-rooted. The crown is highly variable in structure and I doubt whether this variation is of much, if any, taxonomic significance. It may consist of one low, heavy cusp followed by a very small heel. In other cases there is a small anterior basal cusp. The heel is sometimes larger, with a single cusp, or with a larger external and smaller internal cusp. In the Field Museum specimen a metaconid is tending to bud from the tip of the protoconid.

P_3 has an elongate triangular trigonid with the anterior crest descending rapidly, anterointernally, and not cuspidate. The metaconid is immediately posterointernal to the protoconid, nearly as high, and connate with it nearly to the apex. The heel has a distinct small posterointernal cusp (not distinctly shown in Gaudry's figure, but present in all the original specimens examined) and a slightly curved external crest. P_4 has the protoconid and metaconid farther apart, joined by a sharp crest which is notched in the middle. The heel is larger and the external crest is fully marginal and more distinctly crescentic.

The molar trigonid consists of a sharp oblique crest, anteroexternal-posterointernal, with a cusp at each end, the anterior face excavated between them, without median or internal accessory cusps (which occur in most contemporary notoungulates). From the external cusp, protoconid, a small sharp crest falls away rapidly anteriorly and antero-internally, ending at the midline where it sometimes, but rarely, terminates in a small, vague cuspule (paraconid?). The talonid, considerably larger than the trigonid, has an external crescent departing from the posterior side of the protoconid base, more external than in most contemporary notoungulates, and ending on the posterior margin near the internal side. It is clearly composed of two cusps, a heavy crescentic hypoconid and a more conical terminal hypoconulid. The entoconid is nearly conical, not transversely crested, and is close to the hypoconulid, separated by a sharp notch when unworn but merging into it when worn. The talonid basin is broad, excavated, simple, and closed except for the deep notch between the metaconid and entoconid. On M_2 the heel is larger, the hypoconulid projecting farther posteriorly and crescentic,

and the entoconid more independent. Lower molar cingula are often present but of very variable strength and character.

SKULL.—The nasals and the premaxillae are not preserved. Judging from the presence, position and character of the tusks, the reduction and position of the lower incisors, the shape of the preserved part of the maxilla, and analogy with the functionally similar astrapotheres, it may be reasonably inferred that it had reduced premaxillae and retracted nasals.

The facial part of the maxilla has two large, well-marked hollows, one immediately anterior to the zygomatic root, the other higher, anterior

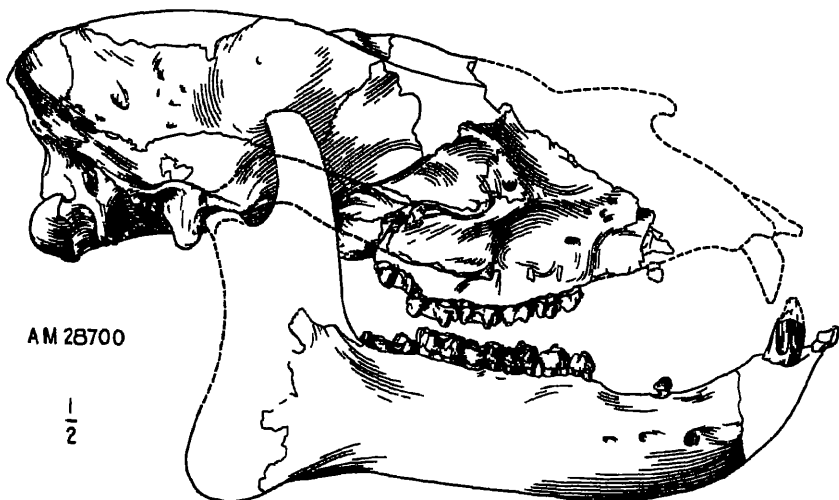


Fig. 1. *Trigonostylops wortmani* Ameghino. Skull and jaws, right lateral view. The parts of the skull in solid outline are from Amer. Mus. No. 28700, and the broken outline of the snout is hypothetical. The shaded part of the jaw is from Field Mus. No. P13323, slightly modified to accommodate it to the skull, and the other parts are restored from several other specimens and Gaudry's figures. One-half natural size.

to the upper part of the orbit. They are separated by a nearly horizontal, rounded ridge running anteriorly from the lacrimal region. On this ridge some distance from the orbit, are four small foramina, and there is another, of about the same size, below and slightly posterior to them. There is no infraorbital foramen in the normal position and I believe these small foramina, jointly, to represent the anterior end of the infraorbital canal—one of the most striking of the many very unusual features of the skull.

The whole base of the zygoma and the whole lower border of the orbit are preserved. As no suture is visible and as the break does appear suggestively as if it had in part followed a suture, it is probable that the jugal did not extend anterior to the postorbital process of zygoma, although this is not certain. The zygoma arises opposite M^{1-3} in this young individual. Probably it would be opposite M^{2-3} in an adult.

The palate is wide, its sides nearly parallel, and as seen from below it resembles a wide shallow channel with raised edges and a nearly flat floor. The broad palatal processes of the palatines extend forward to the level of the posterior parts of P^4 . Near the anterolateral corners, on the suture, there is a pair of posterior palatine foramina, and there appear to have been other very small vascular foramina in the palatines themselves.

The posterior border of the palate and the choanae likewise present very striking features which appear to be quite unique. Near the posterior end of the surface of the palate, the palatines form a prominent median process, with an anterior median crest and a broad, shallow, irregular posterior groove running obliquely up into the choanae. On each side this process is produced into a pointed, wing-like process, between which and the general surface there is a large open groove. Within the choanae the palatines send upward a stout median process, fully united to the presphenoid or vomer, so that the choanae are divided into two wholly separated orifices.

Continuing into the pterygoid crests, in which the pterygoids themselves cannot be distinguished on the specimen, the palatines are at first thick and somewhat recurved below the passage. In the median and posterior parts, however, the crests are vertical and simple, with the edge only slightly thickened and no pterygoid fossae or hamular process.

The supraorbital process and the median part of the zygoma are broken, so that it is not known whether the orbit was enclosed. Its anterosuperior and anterior border is rounded, without development of a distinct crest or tubercle. The lacrimal is a small, simple, rounded element squarely on the orbital rim, with a large foramen a little below the middle. It appears to be in contact only with the frontal and the maxilla.

Within the orbit, between the lacrimal foramen and the posterior end of the infraorbital canal, nearer the latter, there is a foramen on the maxillo-frontal suture. The interorbital foramen lies at the postero-internal corner of the floor of the orbit, at the junction of the palatine, orbitosphenoid, and maxilla. The palatine does not extend above the

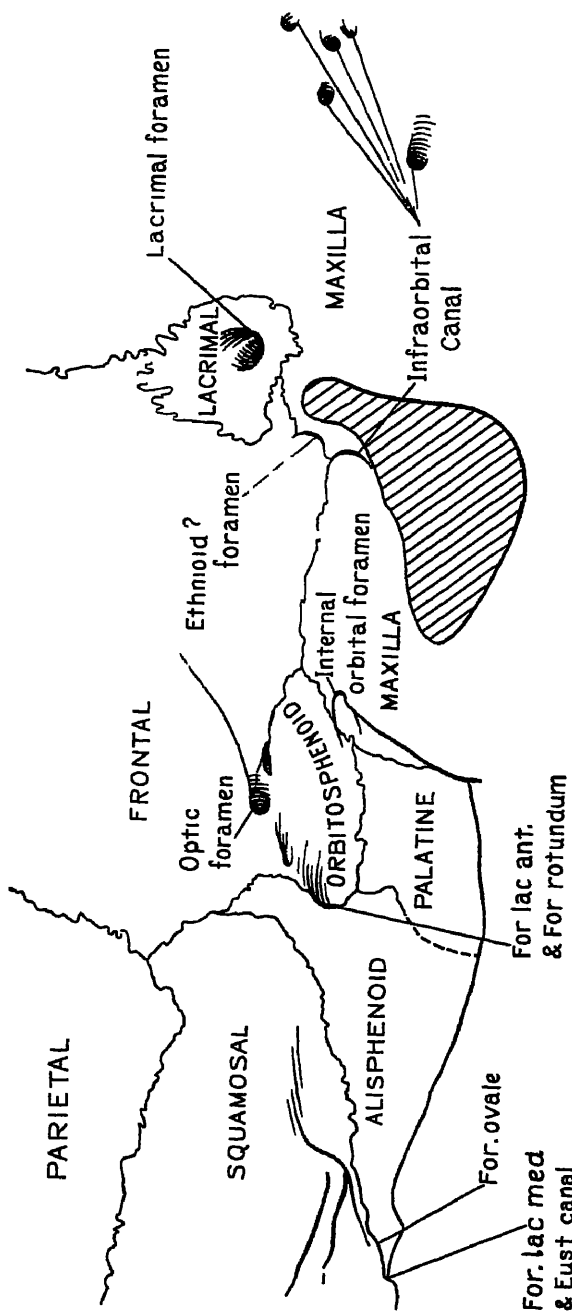


Fig. 2.—*Trigonostylops wortmani* Ameghino. Diagram of the right lateral view of posterior facial and anterior cranial regions. The base of the zygoma is represented as sectioned.

pterygoid crests and plays a very minor part in this region of the skull, containing no foramina here. The orbitosphenoid was apparently well developed, but its upper limit is one of the very few sutures which careful scrutiny did not reveal. In the orbitosphenoid or along its edges there are four foramina. The most posterior is a large fissure between alisphenoid and orbitosphenoid, clearly the foramen lacerum anterius. The foramen rotundum must be merged with this also, as it is not present in the alisphenoid itself. Immediately anterior to the upper edge of this, and in part covered by this edge, is a much smaller foramen directed forward. This may be the optic foramen, but this function belongs with greater probability to another larger and more independent foramen above and anterior to this. The fourth foramen, also directed anteriorly, is the smallest of all and is near the lower edge of the groove running forward from the supposed optic foramen.

The alisphenoid, apparently fused to the basisphenoid and perhaps also to the pterygoid, which cannot be distinguished, is long antero-posteriorly, its course nearly horizontal, and shallow vertically. It extends for a short distance above the foramen lacerum anterius, but does not reach the parietal here. The frontal region is domed, the frontals themselves being markedly convex and inflated by large sinuses in at least their posterior part, which is all that is preserved of them on the skull roof. The frontals here form an angle, directed backward, clasped between the divergent anterior ends of the parietals. The frontals are also extensively developed in the orbital wall.

The parietals are large, long elements, but their great development is due to the large muscular origins on them rather than to their taking any unusual part in the roofing of the brain case. They form a tremendous sagittal crest, very high and long. The extreme posterior end is formed by the supraoccipital (or interparietal), the anterior end of which, in the crest, is wedged between thin plates of the parietal, but far the greater part of the crest is on the parietals only. At about the post-orbital constriction the crest ends, as such, dividing into two divergent angulations formed by the parietals, which here clasp between them the sharply domed frontals. In the posterior parts of the parietals and along the parieto-squamosal sutures there are a number of large vascular foramina. The parietals do not form any significant part of the lambdoid crests.

The squamosal forms a moderate part of the lateral cranial wall. This part is triangular, much elongate antero-posteriorly, its only marked irregularity a projection near the posterior angle, between the parietal

and the lambdoid crest. The squamosal projects posterior to the auditory meatus, but the projection is very slight and is above, rather than behind, the tympanic and does not form a post-tympanic process. The postglenoid process is heavy, but low and blunt, and is moderately expanded transversely. The postglenoid foramen is at the internal end of the postglenoid process, in the squamosal, but very near its suture with the tympanic. The glenoid surface is nearly flat and approximately horizontal, slightly tilted so as to face a little backward and outward. It is nearly equidimensional. From this point the squamosal extends forward in the cranial wall, becoming a featureless and nearly vertical plate which reaches the frontal in the region of the postorbital constriction.

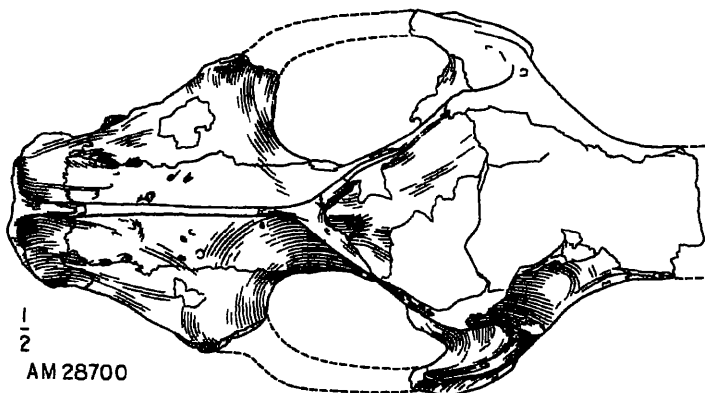


Fig. 3.—*Trigonostylops wortmani* Ameghino. Superior view of skull, Amer. Mus. No. 28700. One-half natural size.

The occiput, which is nearly vertical, is of equal height and width and is very strongly sculptured. Its elements appear to be fused. The supraoccipital region is marked by a broad concavity, divided by a small median vertical ridge, the upper margin of which is very rough. Lateral to the rounded ridges bounding this concavity on each side, is a smaller, roughly triangular concavity facing more outward and downward. On the lateral edge of this is a narrow notch leading into a vacuity through which the mastoid is seen. From the mastoid a posterosuperior, styli-form process extends backward and upward to appear on the surface of the occiput where it is clasped between sutures with the exoccipital. The paroccipital processes are moderately developed, extending to about the same level as the postglenoid processes, and elongate anterointernal-

posteroexternally. The occipital condyles are well rounded, separated basally and directed almost straight posteriorly. The foramen magnum is slightly transverse. Nearly two centimeters of the sagittal crest and almost all of the very strong lambdoid crests are formed by the supra-occipital. The lambdoid crests are not very distinctly emarginate, but become much less prominent about two centimeters before reaching the upper rim of the meatus, and here the superior surface is formed by the squamosal, and the inferior by the exoccipital. The extensive dorsal exposure of the upper part of the fused occipital elements may cause suspicion that a distinct interparietal has also been merged with this complex, but as the exposure is due rather to the great development of muscular crests than to any part in the dorsal roofing of the actual brain-case, it may not really involve an interparietal.

The basioccipital, basisphenoid, and presphenoid are all relatively long and narrow, giving the cranium proper a very elongate aspect, more noticeable in this ventral view than dorsally. These elements lie in a straight line, not significantly inclined with respect to each other, and are also nearly parallel to the palatal surface, the face being only very slightly depressed relative to the basicranium. The basioccipital-basisphenoid junction is slightly swollen and the presphenoid bears two narrow converging grooves, but these bones are otherwise nearly featureless.

The auditory region is highly distinctive, fundamentally unlike any true notoungulate, with some distant and doubtful resemblance to the astrapotheres, and unique in general, although with some minor details suggestive of diverse groups of mammals manifestly quite unrelated to *Trigonostylops*. The tympanic appears to be a single element, although the possibility of complete fusion of two or three elements is not absolutely excluded. It is a thick, heavy bone but is not at all inflated and the lower surface is flattened and nearly horizontal. Apparently the original tympanic ring was horizontal, or gently inclined, certainly not near verticality. It lies with a loose suture, perhaps even an open contact, against the junction of the basioccipital and basisphenoid but has strong sutures against the squamosal anteroexternally and against the exoccipital posteriorly and also has ascending processes, transversely expanded, on each side of the porus acusticus, which are in tight sutural contact with the squamosal. The flattened ventral exposure of the bone is of very irregular shape. The outer part probably formed the floor of the internal end of the external auditory meatus, although an ossified meatus can hardly be said to be present in the ordinary usage of the

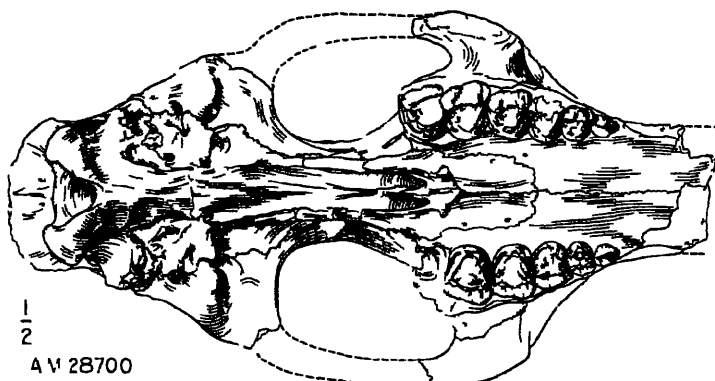


Fig. 4.—*Trigonostylops uoitmani* Ameghino. Palatal view of skull, Amer Mus. No. 28700 One-half natural size

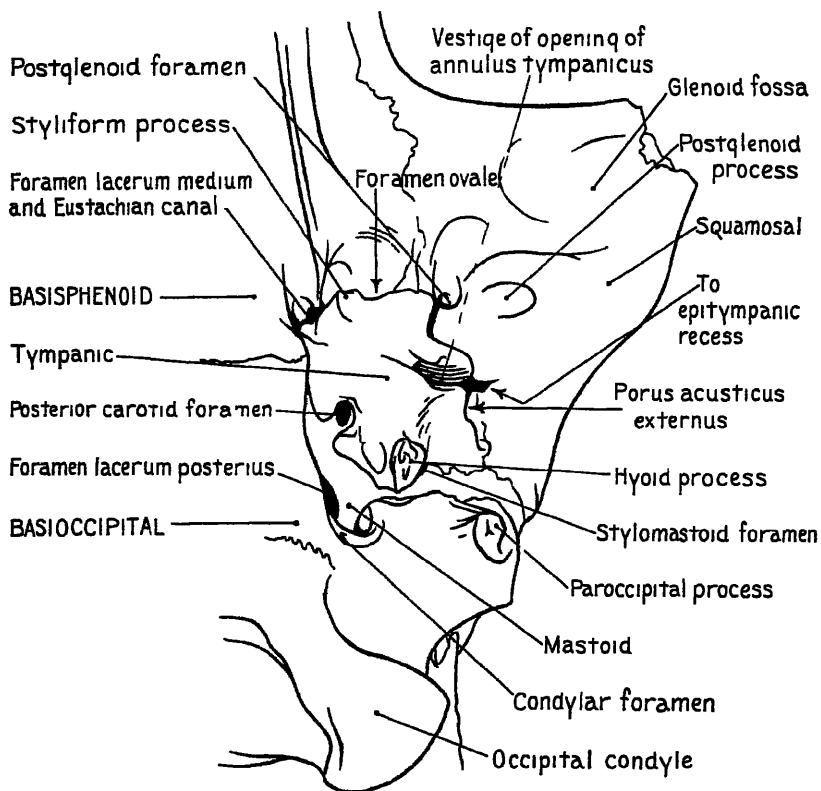


Fig. 5.—*Trigonostylops uoitmani* Ameghino Diagram of ventral view of left basicranial region

term. Along the anterior part of this portion of the tympanic there is a deep narrow notch.¹ The anterointernal end of the tympanic is produced into a short styliform process which underhangs a very large deep transverse pit, extending upward and backward and roofed by the alisphenoid. This pit is double and its outer part rather clearly served for the exit of the mandibular nerve, thus being homologous with the foramen

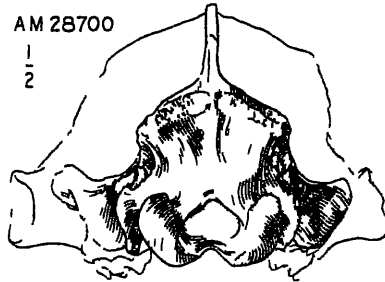


Fig. 6—*Trigonostylops wortmani* Ameghino Occipital view of skull, Amer Mus. No. 28700 One-half natural size.

ovale, while the inner part probably combined the functions of the foramen lacerum medius and the Eustachian canal. Slightly posterior to the middle side of the tympanic is a prominent nearly circular notch which I take to represent the posterior carotid foramen. On the posterior margin of the tympanic there is a roughly hemispherical swelling, which may not belong to the bone itself but may be a descending process from the petiotic or may be an independent element. In any event, this seems to be the place of attachment of the hyoid arch, and the margin of the tympanic around it is probably homologous with the vagina hyoidei, although it does not form a true and prominent vagina strictly speaking, as in the notoungulates, for instance. The stylomastoid foramen is immediately external to this, and is definitely anterior and not very close to the anterointernal end of the paroccipital process.

Posterior to the tympanic there is a large oval vacuity, in the roof of which the mastoid is extensively exposed. Along the medial and posterior edges of this is the foramen lacerum posterius, and in the same pit, although with a distinct opening, is the condylar foramen, which is thus far in advance of the condyle and directly internal to the anterior end of the paroccipital process.

¹Apparently a remnant of the original circular opening of the nearly horizontal ring, not completely closed by ossification, extending inward from it—a normal condition in a few mammals and an occasional abnormality in others, including man. Here it is symmetrical on the two sides and was probably normal.

There is not, as in notoungulates, an epitympanic sinus extending backward and upward into the posterior part of the squamosal, near or along the lambdoid crest. But in the anteroexternal part of the roof of the auditory cavity there is a large circular opening which runs forward and upward into a sinus of moderate size, not particularly noticeable externally, in the part of the squamosal forming the posterior root of the zygoma, chiefly above, internal, and also somewhat posterior to the glenoid surface.

For convenient reference to their very important characters, what can be determined regarding the cranial foramina may be gathered together as follows:

Optic foramen: apparently independent and some distance above and anterior to the foramen lacerum anterius, presumably in the upper part of the orbitosphenoid.

Foramen lacerum anterius: large and with its usual relations

Foramen rotundum: not present in the alisphenoid and hence presumably confluent with the foramen lacerum anterius

Foramen ovale: not surrounded by the alisphenoid externally, but relatively posterior and ventral in position, between the alisphenoid and the tympanic, and in a common large pit with the foramen lacerum medium

Stylomastoid foramen: at the posterior edge of the tympanic, external to the hyoid attachment and anterior to the paroccipital process

Foramen lacerum posterius: large and in its normal position between petiotic and basioccipital and opening into a large pit or gap left between the latter and the tympanic.

Condylar foramen: opening into the pit just mentioned, internal to the paroccipital process and some distance anterior to the condyle.

Infraorbital foramina: multiple, relatively high on the face, and far anterior to the orbit.

Internal orbital foramen: small, at the posterointernal corner of the orbital floor at the junction of the maxilla, palatine, and orbitosphenoid.

Ethmoid foramen: although unusual in position, the foramen on the maxillo-frontal suture in the anterointernal wall of the orbit may fulfil this function.

Posterior palatine foramen: on the maxillo-palatine suture near the antero-external angle of the palatine, with subsidiary foramina in the palatine.

Foramen lacerum medium: a large opening at the antero-internal corner of the tympanic and confluent externally with the foramen ovale.

Posterior carotid foramen: in a large notch on the posterointernal border of the tympanic.

Postglenoid foramen: immediately medial to the postglenoid process.

Choanae: immediately posterior to M^3 , considerably narrower than the palate, and completely divided into two by a median ascending process from the palatines.

Lacrimal foramen: large, simple, without a spine, on the rounded orbital rim

Eustachian canal: apparently confluent externally with the foramen lacerum medium.

External auditory aperture: roofed by the squamosal, and with the tympanic forming a short partial meatus by anterior, posterior, and incomplete inferior plates

Foramen magnum. large and very slightly transverse

Miscellaneous, vascular or unidentified

A small foramen anterior to the supposed optic foramen

Several large vascular foramina in the parietal

Vacuity in the occipital exposure of the exoccipital, through which the mastoid projects

MANDIBLE—The most striking feature of the lower jaw is the long, cylindrical symphysis. Its width and depth are nearly equal and the lateral and inferior surfaces are continuous and rather evenly rounded. The upper surface is marked by a groove, limited by crests continuing the dental borders. The interior is occupied almost entirely by the closely appressed, triangular to semicircular canine roots. The symphysis extends to the anterior border of P_2 . There are two mental foramina, one beneath each half of the diastema. The horizontal ramus beneath the cheek teeth is of normal proportions, its lower border nearly straight and parallel to the dental border. The angular region is large and flat, expanding abruptly below the lower border of the horizontal ramus. The condyle is well above the molar level, and the coronoid is high and slender.

GENERIC AND SPECIFIC TAXONOMY

In addition to *Trigonostylops* itself, Ameghino referred to the Trigonostylopidae the genera *Pleurystylops*, *Edvardocopeia*, and *Pseudostylops*. These are all extremely dubious genera and I see no reason for retaining any of them in this family. *Pleurystylops* is based on a single deciduous molar with no particular resemblance to this group. *Edvardocopeia* is known chiefly from an upper premolar, indeterminate but probably entelonychian. *Pseudostylops* is applied to an upper premolar very unlike *Trigonostylops*, probably of an entelonychian although possibly an astrapotheres. The genus *Scabellia*, based on a few broken, isolated teeth, was placed by Ameghino in the Albertogaudryidae. So far as such poor material (to which may be added a complete, but also isolated, molar found by us) is determinable at all, it indicates a good, distinctive genus with more apparent resemblance to *Trigonostylops* than to *Albertogaudrya* or other real astrapotheres. It differs from *Trigonostylops* chiefly in having the hypocone larger and more internal. *Scabellia* is recognized as a valid genus and tentatively placed in the Trigonostylopidae. Roth's genus "*Staurodon*" = *Chiodon* Berg is obviously very close to *Trigonostylops*. The only visible distinction possibly

generic is the absence of P_1 . I do not consider this sufficient evidence to separate the genera, and consider *Chiodon* a synonym of *Trigonostylops*.

The specific taxonomy of the genus is in a very confused condition which can hardly be cleared up now. Ameghino named thirteen species, and "*Staurodon*" or "*Chiodon*" *gegenbauri* and *supernus* make fifteen. Of Ameghino's species, ten are based essentially on isolated upper molars, in several cases with other doubtfully associated separate teeth, all supposed by him to be M^1 but surely in some cases M^2 or M^3 and so not strictly comparable. One species is based on P^{3-4} and P_{2-4} , not of the same individual and not comparable with any other types, and another is based on two second lower molars of different individuals and likewise not comparable with any other type. *Trigonostylops supernus* (Roth) is based on a lower canine and M_3 , apparently not correctly associated, and again not comparable with other types (except that of *T. gegenbauri*). Only two species are based on types that are really adequate: *T. subtrigonus* Ameghino, on truly associated M^{1-3} , and *T. gegenbauri* (Roth), on a good lower jaw. Even these are not comparable with each other. Upper and lower teeth of a single individual have not been found surely associated. In view of the nature of the types, the unduly large number of proposed species, and the variable and often highly questionable characters used for definition, it is practically impossible to reduce this taxonomy to any secure and useful basis.

If the criteria used by Ameghino are accepted, then every specimen known to me will have to be the type of a separate species. This is obviously not only impractical but contrary to reality. It is impossible to believe, for instance, that Ameghino is correct in thinking that fifteen specimens, all of about the same size and general character and all from the same horizon and locality, represent thirteen distinct species. They might represent two species, perhaps even three, but hardly more. Just what the real specific characters and differentiation of the genus are, will not be known until a great many more than the four or five really determinable specimens now at hand have been discovered, and the large number of names already proposed simply confuses the issue and makes any proper redefinition or revision impossible.

Discussion of these various species and their supposed distinctive characters is deferred to the monograph of the fauna. For purposes of this preliminary note and of record, Roth's specimen may be retained as *Trigonostylops gegenbauri* (Roth), and the Field and American Museum specimens may be referred to *T. wortmani* Ameghino. They could well

belong to the same species (although the localities are widely different and there is no proof that they do) and both are near the size of *T. wortmani*. Our specimen differs in having M^2 and M^3 wider than the type upper molar of *T. wortmani*, and M^1 somewhat smaller, but not enough to exclude the possibility or probability of identity. They are probably from the same locality, and from a practical point of view it is well to employ the name *T. wortmani* if possible, for it is the only specific name that is surely not a synonym (being the oldest).

RELATIONSHIPS

In 1897 (p. 492) Ameghino placed *Trigonostylops* in the family Notostylopidae, then new, in the Order Tillodonta, but with the remark that "il est probable que plus tard ce genre deviendra le type d'une famille distincte probablement à denture complète." In 1901 (p. 390) he fulfilled his own prophecy by creating a family Trigonostylopidae, which he placed in the Amblypoda and considered ancestral to the Pantolambdidae. He later (e.g., 1906) retained the Trigonostylopidae in the Amblypoda, but as a sterile offshoot, having removed the Pantolambdidae to the Condylarthra. Aside from his linking of the Trigonostylopidae in various ways with Holarctic families, views never accepted by other students, his opinion involved collateral relationship with the astrapotheres. This suggestion was accepted by subsequent students, the absence of any better specimens making any reconsideration futile until the present discovery. Scott, Schlosser, Weber, and Abel, and in fact almost all recent authorities known to me, have placed *Trigonostylops* in a distinct family of the Order or Suborder Astrapotheria.¹

Now that *Trigonostylops* from one of the least known has become one of the best known of early South American mammals, a restudy of its relationships becomes possible and obligatory.

In the first place, it would be most natural, *a priori*, to suppose *Trigonostylops* a notoungulate, but this is certainly incorrect. It was a most improbable conclusion from the teeth alone, and is absolutely excluded by the skull. The teeth have certain resemblances to the most ancient and primitive notoungulates, but these are really nothing more than traces of protoungulate inheritance, not tending to link these two groups together especially. Even the most ancient true notoungulates have certain basic characters, such as a large hypocone, characteristic metaloph, crochet, and transversely crested entoconid pillar which

¹Osborn (1910, p. 560) does, indeed, place *Trigonostylops* in the Notostylopidae, but this may have been done inadvertently as it does not appear to have been based on restudy and it was fairly clear even then that the two families were very distinct. Gaudry (1904, p. 13) gives no opinion regarding affinities, but seems also to imply that *Trigonostylops* is related or even ancestral to *Notostylops*.

underlie the whole notoungulate group and are perfectly typical of it, in fact indispensable for its definition, but which are quite absent or very differently developed in *Trigonostylops*. The skull roof, face, palate, and occiput of *Trigonostylops* have no characters confined to the Notoungulata or even characteristic of them, and do have many characters quite unknown among notoungulates. As the majority of these latter characters are, however, unique or nearly so in any group, they are to be viewed as specializations not absolutely excluding the possibility of very remote relationship. Most important are the cranial foramina and, especially, the ear region. Here, as in the dentition, and to even greater degree, there are numerous characters which exist in or underlie the whole notoungulate group, even in its earliest and most primitive members, and which are lacking or developed in a fundamentally different way in *Trigonostylops*. Thus in the auditory region (see especially Patterson 1932, and his citations), the following are the more essential characters in the notoungulates, contrasted with their development in *Trigonostylops*:

Notoungulata	<i>Trigonostylops</i>
Tympanic forming a large inflated bulla	Tympanic not inflated and of very different form.
Epitympanic sinus above and behind auditory meatus.	Epitympanic sinus not strictly homologous, lying in quite a different part of the squamosal
Ossified tubular auditory meatus.	Auditory meatus incompletely ossified, shorter, not tubular
Deep vagina processus hyoidei at postero-external corner of bulla	Hyoid attachment posterior, of different character, not forming a deep vagina.
Stylomastoid foramen between porus acusticus and vagina processus hyoidei.	Stylomastoid foramen posterior to porus, between it and paroccipital process
Frequent, but not invariable, occurrence of styloid process	Styloid process present, but blunt and poorly developed
Mastoid poorly exposed or hidden (except in most Entelonychia and a few others); petrotic not exposed in basicranium	Mastoid with small occipital exposure; petrotic extensively visible in basicranium
Prominent crest on lower surface of meatus (except in some typotheres).	Crest absent.

Aside from those closely related to the auditory region, the cranial foramina have not yet been sufficiently studied in the Notoungulata to permit many generalizations. One feature, the absence of foramina in the alisphenoid, between the foramen lacerum anterius and the foramen lacerum medium, does appear in many notoungulates and also in

Trigonostylops, but this is not quite invariable in the Notoungulata, is not confined to them, and is offset by the other differences between that group and *Trigonostylops*

On morphological grounds there is no more reason for referring *Trigonostylops* to the Notoungulata than to any other ungulate group, and apparently insuperable objections to so placing it. This conclusion, of course, also disposes of the possibility of special relationship between *Notostylops* and *Trigonostylops*, as the former is a typical notoungulate.

Turning to the astrapotheres,¹ the evidence for relationship to *Trigonostylops* is better, but far from conclusive. Unfortunately research in this respect is hampered by lack of knowledge of the skull of any early astrapothere. Judging from their teeth, about all that is known, *Astraponotus* and, still more, *Albertogaudrya* are much more primitive than the later astrapotheres, and comparison of their skulls, now completely unknown, might be expected to show considerably greater resemblance to *Trigonostylops*.

The dentition gives the best evidence for astrapotherian affinities, and the tentative conclusion of previous work, when this was the only evidence available, was justified. *Astrapotherium* itself differs very decidedly from *Trigonostylops*, but if its probable structural ancestry is traced back to *Albertogaudrya*, certain evolutionary trends are distinctly visible, and if these trends are hypothetically projected back to a still more remote ancestry, a pattern rather like *Trigonostylops* emerges as a distinct possibility. The (inverse) sequence from *Astrapotherium* to *Albertogaudrya* has crowns decreasing in height; in *Trigonostylops* they are still lower. The astrapothere canines have open roots and are enormously long in their latest form, and are rooted and relatively smaller in their earliest; in *Trigonostylops* the enlarged teeth, probably canines,² are also rooted and have still lower crowns. Astrapothere premolars are very much reduced in the later and much less so in the earlier genera; in *Trigonostylops* they are apparently undergoing the same sort of reduction but have not yet gone so far. The lower molars of *Trigonostylops* are rather similar to those of *Albertogaudrya*, although they are more primitive in being more cuspidate and apparently aberrantly specialized in the reduction

¹In this discussion it is assumed that the Astrapotheria are an order distinct from the Toxodontia or Notoungulata (a view that will be defended elsewhere), and in general the term "astrapothere" or "true astrapothere" is meant to include the Albertogaudryidae and Astrapotheriidae, but not necessarily the Trigonostylopidae.

²As already mentioned, it is not certain that these are canines and not incisors. One of the reasons for considering them canines is their resemblance to astrapothere canines. They are valid evidence for true affinity, and not convergence, only if they do prove really to be canines, and in the meantime are suggestive without being in any way conclusive. To conclude, without this comment, that the enlarged canines of *Trigonostylops* are direct evidence of astrapothere relationships, is dangerously near to arguing in a circle.

of the protoconid-paraconid wing. The upper molars are the most important in this connection, and they are also the weakest link in the chain of dental evidence tending to connect *Trigonostylops* to the astrapotheres. In *Trigonostylops* there is a primitive trigon, a small hypocone excluded from the main crown pattern, and a closed central basin without any secondary crests (cristae or crochet). In the later astrapotheres the pattern is very, and apparently fundamentally, different, with a relatively large hypocone united to the ectoloph and forming a strong metaloph, a median valley open on the internal side, a strong secondary crest, cutting off an external fossette, and a crested posterior cingulum forming a posterior fossette. In *Albertogaudrya*, however, the upper molars are much less notoungulate-like and less different from *Trigonostylops*: the metaloph is at best incipient, with metaconule and hypocone separate and the latter nearly conical, the posterior cingulum relatively slight, a crista only very faintly indicated, and the median valley not fully open between hypocone and protocone. From this type to *Trigonostylops* is still a marked structural step, but it is a conceivable one and is more or less in the direction of the inverse sequence from *Astrapotherium* to *Albertogaudrya*. What is known of the incisors in *Trigonostylops* does not favor astrapothere affinities. As figured by Gaudry, the lower incisors are not of the bilobed pattern so characteristic of astrapotheres, and there are only two pairs as opposed to three in later astrapotheres. In general, about the most that can be said for the evidence of the dentition, upper and lower, is that it is not incompatible with a theory of relationship between *Trigonostylops* and astrapotheres. The dentition, however, provides no very impelling evidence in favor of such affinities, and the resemblances, not very deep-seated, could equally well be explained as due only to a considerably more remote common ancestry and a limited degree of convergence. A remarkable feature in the astrapotheres, difficult to explain or evaluate and not wholly germane here, is the fact that in *Astrapotherium* itself, as pointed out by Scott, the molar pattern is on the whole very notoungulate-like, while in *Albertogaudrya*, which appears to be structurally ancestral to *Astrapotherium*, the molars are very much less notoungulate-like. If the history is correctly interpreted, it would seem to call for a high degree of convergence in molar pattern between astrapotheres and notoungulates, and to separate them more widely than would be supposed from a study of the dentition of the later forms only.

Turning to the skull, it goes far to oppose close affinities between *Trigonostylops* and the astrapotheres. Its general aspect has some similarities, but only in features which are in any event more probably

due to habitus than to heritage, and these are more than offset by differences. In the more important structural details, the differences are numerous and essential. The more important of them are as follows:

<i>Astrapotherium</i> ¹	<i>Trigonostylops</i>
Infraorbital foramen single, immediately anterior to orbit and overhung by orbital rim.	Infraorbital foramina multiple and far from orbit.
Orbital rim prominent and crested.	Orbital rim low and rounded.
Lacrimal foramen, and apparently also the lacrimal itself, wholly intraorbital.	Lacrimal foramen and lacrimal on orbital rim.
No ventral projection at posterior palatal rim.	Peculiar palatine process—see above.
Choanae tubular, undivided.	Choanae more or less tubular, but divided by bony median partition.
Interorbital foramen apparently entirely in palatine and posterior to maxilla	Interorbital foramen at junction of palatine, maxilla, orbitosphenoid.
Sagittal crest very short.	Sagittal crest very long
Great overhanging temporal crests.	Temporal crests practically absent.
Strong post-tympanic process of squamosal, closely applied to the paroccipital process, and the latter considerably longer (vertically) than the high post-glenoid process.	Post-tympanic process of squamosal very short, practically absent, far removed from paroccipital process, and latter much shorter, not exceeding the low post-glenoid process.
The strong postglenoid and paroccipital processes closely approximated, especially distally, and enclosing a deep narrow notch	The weak postglenoid and paroccipital processes far apart, not less so distally, with a broad open space between them
Occiput much higher than broad, strongly emarginate on each side.	Occiput of equal height and breadth, not distinctly emarginate
No occipital exposure of mastoid.	Occipital vacuity, with good exposure of mastoid.
Basisphenoid-presphenoid exposures relatively short.	Basisphenoid-presphenoid exposures very long.
Condylar foramen large, separate, at posterointernal end of paroccipital process.	Condylar foramen small, opening into a large pit into which the posterior lacerate foramen also opens, internal to and some distance from the paroccipital processes
Whole ventral aspect of the auditory region exposed only in the roof of a small, deep, constricted pit.	Auditory region broadly exposed ventrally, periotic nearly on a level with the surrounding elements.
Tympanic apparently small and loosely attached (possible space for it is small, and it has not been found attached even to well preserved skulls).	Tympanic large and strongly united by sutures to the surrounding bones.

¹In addition to Scott's masterful study of the Santa Cruz *Astrapotherium* (Scott, 1928), a fine skull of *Astrapotherium*, Amer. Mus. No. 9278, was available for direct comparison, and it reveals some details not fully described by Scott.

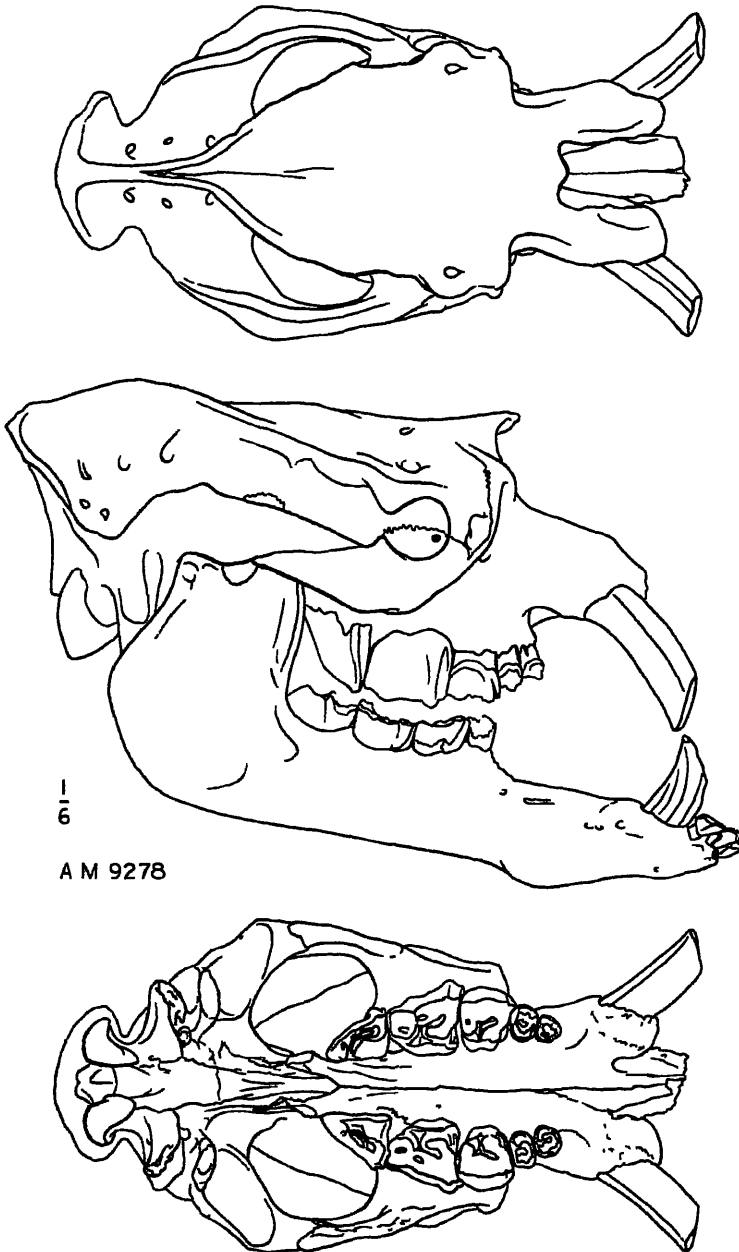


Fig. 7.—*Astrapotherium magnum* (Owen). Skull, dorsal, right side, and palatal views. Amer. Mus. Nat. No. 9278 One-sixth natural size

Hyoid process crowded into a vertical groove along the junction of the post-tympanic and paroccipital processes.

Hyoid process on margin of the tympanic and far removed from paroccipital or post-tympanic processes.

As against these very impressive differences, and others less marked or apparently of less importance, there are a few special resemblances:

The frontals are domed and contain large sinuses in both (but their shape is different and their relations to the parietals, not very clear in *Astrapotherium*, are also probably quite distinct).

There is no separate foramen rotundum in either.

Both have a foramen (possibly homologous or analogous to an ethmoid foramen) in the orbit between the lacrimal foramen and the posterior end of the infraorbital canal.

The arrangement of foramina in and around the orbitosphenoid is somewhat unusual, although not unique, and is much the same in both.

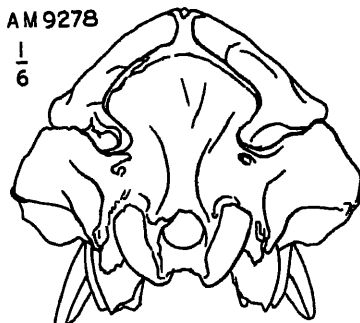


Fig. 8—*Astrapotherium magnum* (Owen). Skull, occipital view. Amer. Mus. No. 9278. One-sixth natural size.

The foramen ovale in both is at the posterior edge of the alisphenoid, not distinctly separated externally from the foramen lacerum medium, and the alisphenoid is not pierced anywhere on its exposed surface. What probably corresponds to the epitympanic recess in both communicates with a small sinus in the zygomatic root of the squamosal, anterior to the ear region.

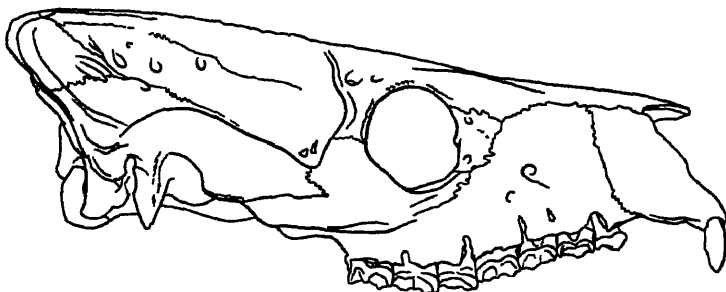
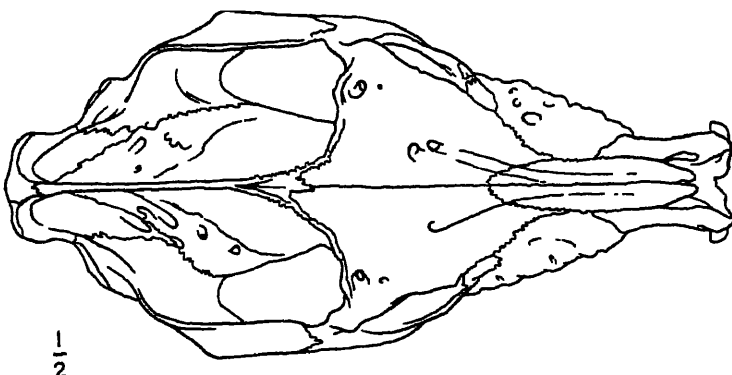
If, as is quite possible, these are valid evidences of affinity, they do not unite these two families to the exclusion of all others, for all these points of resemblance seem to be developed to some degree in the *Litopterna*.

Some of the differences of *Astrapotherium* from *Trigonostylops* are probably due in some degree to the less age of the former and would

perhaps be less marked in an astrapothere of the same antiquity as *Trigonostylops*. Many if not most of the essential distinctions of *Trigonostylops*, however, are specializations either more advanced than even those of *Astrapotherium* or else widely divergent from them. There is little reason to suppose that the gap between the two groups would be very much less if contemporaneous genera were available for comparison. In view of the great distinctions and of the fact that the only essential points of resemblance are also seen in a group, the Litopterna, commonly considered as an order distinct from the Astrapotheria, the evidence hardly warrants positive reference of *Trigonostylops* to the Astrapotheria.

The possibility that *Trigonostylops* is a litoptern, or at least more closely related to the Litopterna than to other groups, has apparently never been discussed, but there is something to be said for it. The dentition differs sharply from any Santa Cruz litoptern, although hardly more so than from Santa Cruz astrapotheres except for the probable canine tusks. But as in the case of the astrapotheres, these differences are greatly reduced if earlier litopterns are taken into consideration. In some of the latter, *Polymorphus* for example, the lower cheek teeth are strikingly like those of *Trigonostylops*, a resemblance not amounting to identity, but rather closer than any other comparison made. The upper cheek teeth, or particularly the molars, show somewhat less resemblance, but even here such forms as *Heterolambda* or *Ricardolydekkeria* show the distinct possibility of a relationship. The points of special resemblance, striking in view of the very different conditions in all other South American ungulates, are chiefly the primitive, triangular, basined trigon and the very small, cingulum-like hypocone. The differences of *Trigonostylops* are chiefly the absence or less development of mesostyle, metastyle, protostyle, and protoconule and the less symmetrical crown. No very intimate relationship is probable on this basis, but the possibility of a collateral relationship is not opposed. No known litoptern has canine tusks, but it is not absolutely certain (although very probable) that these are canines in *Trigonostylops*, and in any event such a divergent development does not necessarily oppose some degree of affinity. On the whole the evidence of the teeth is that relationship is not very close either to astrapotheres or to litopterns, and that on this evidence alone *Trigonostylops* may be somewhat closer to the astrapotheres.

The skull is more suggestive of possible affinities of *Trigonostylops* with the Litopterna. The special resemblances to the Astrapotheria are in almost equal degree resemblances to the litopterns also. In the latter the frontals are also domed, although less so than in *Trigonostylops*, and



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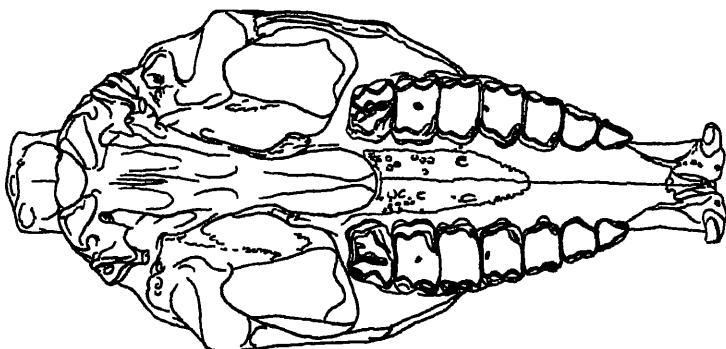


Fig. 9.—*Proterotherium canum* Ameghino. Skull, dorsal, right side and palatal views. Amer. Mus. No. 9245. One-half natural size.

contain sinuses; in them the foramina in and around the orbitosphenoid also have a general resemblance to *Trigonostylops*; the foramen rotundum is externally confluent with the foramen lacerum anterius¹; the foramen ovale is not confluent with the foramen lacerum medium, but lacks little of being so, the two separated only by a thin plate of bone; and they also have a small epitympanic sinus chiefly anterior to the periotic.

It has always been said that an epitympanic sinus is lacking in astrapotheres and litopterns. This is true only in the sense that there is none in the position of that of the notoungulates and that it is small and does not form a swelling noticeable externally. But in both these groups and in *Trigonostylops* there is a small cavity in or near the base of

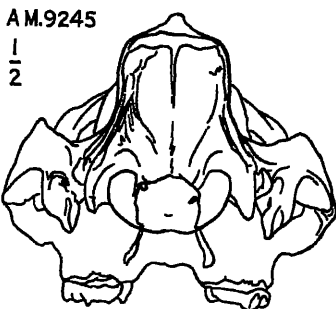


Fig 10 —*Protheroherum canum* Ameghino. Skull, occipital view. Amer. Mus. No. 9245. One-half natural size.

the zygomatic process of the squamosal which communicates with the ear region by a canal running downward and slightly backward. This may perhaps also be considered as literally an epitympanic sinus, although not strictly homologous with this structure in its more usual development. In all three groups it seems to consist of a single rather small cell, largest in *Trigonostylops*.

In addition to these points which suggest the possibility that astrapotheres, litopterns, and *Trigonostylops* may have been derived from the same, but perhaps rather remote, ancestral group, there are a few points in which *Trigonostylops* resembles the Litopterna more than it does the Astrapotheria. The skull roof, at least that portion behind the orbits, is much more litoptern- than astrapothere-like in *Trigonostylops*, especially noticeable in the relations of frontals and parietals and the length

¹Scott supposes it confluent with the foramen ovale, but this seems less probable. Their functions, for transmission of the maxillary and mandibular nerves respectively, are such as to cause them to point in different directions and not to tend to bring them close together. Cases of such confluence are extremely rare or non-existent among recent mammals, while the external confluence of the foramen rotundum and foramen lacerum anterius is of very common occurrence.

and structure of the temporal, sagittal, and lambdoid crests. The post-tympanic process in litopterns is generally about intermediate between astrapotheres and *Trigonostylops* in development, and the auditory notch and general exposure of the periotic region are also more or less intermediate, while the paroccipital process and hyoid process are slightly nearer to *Trigonostylops*. The tympanic was loosely fixed and is very poorly known, but in at least some cases was flattened and scale-like, and at least to that extent resembled *Trigonostylops*. These special resemblances are not profound, and most are apparently primitive or adaptive rather than evidence of definite relationship. In other respects, *Trigonostylops* is as unlike litopterns as astrapotheres, or more so.

Trigonostylops also exhibits some of the points in which the Litopterna resemble the North American Condylarthra. But as it is considerably farther from the condylarths in structure than are litopterns, and as it has no condylarth characters not also present in litopterns (with the possible single and not important exception of enlarged canines), no special affinity is indicated, and this line of evidence need be followed no farther at this time.

The general conclusions regarding the affinities of *Trigonostylops* are:

1. That it is an extraordinarily isolated placental of the general ungulate cohort, showing no evidence of close affinity with any other known group.

2. That it is a very aberrant branch from some ancient and primitive stock, retaining an archaic character despite its specialization in many features.

3. That it is not at all close to the Notoungulata and cannot be referred to that Order.

4. That it shows some evidence of collateral relationship to the astrapotheres on one hand and litopterns on the other, and is perhaps slightly closer to the former.

5. That it may hence be very tentatively concluded that from a primitive and remote ungulate stock, probably in or very near the Condylarthra, arose the litopterns, retaining rather more of these ancestral characters, and astrapotheres, more strongly aberrant, and that *Trigonostylops* also came from this remote ancestry, possibly nearer to or even in the most ancient astrapothere line, but diverging strongly in a third direction.

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BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. XXIII¹

TWO NEW BIRDS FROM MICRONESIA

BY ERNST MAYR

There are two specimens of short-eared owls among a collection of birds from Ponape Island received by the Museum two years ago from the Whitney South Sea Expedition. Knowing the migratory habits of this species, I considered the two birds stragglers from Asia, and neglected in the rush of other business to examine them carefully. During the preparation of a list of Polynesian birds, recently, I came across Finsch's notes that the species was resident on Ponape, which fact caused me to look up the specimens again. A hasty comparison revealed at once their distinctness, and since there is very little Palearctic material in our own collection, I sent the birds to the Museum of Comparative Zoology. Mr. James L. Peters of that institution examined the specimens very carefully, comparing them with the entire M C Z material, and not only confirmed the differences noted by me, but added a few that I had overlooked. He concluded his letter by saying: "Your bird is an extremely well-marked insular race and decidedly worth naming." I am greatly obliged to Mr. Peters for his valuable notes. The presence of an endemic race of the short-eared owl in Micronesia is of great zoogeographical interest.

Asio flammeus ponapensis, new subspecies

TYPE.—No 331224, Amer Mus. Nat Hist; ♀ ad; Ponape Island, Caroline Islands; December 12, 1930; W. F. Coultas

SUBSPECIFIC CHARACTERS.—Averaging slightly smaller than *flammeus*, and with a comparatively short tail, but much larger than *sanfordi* (wing, 276–288 mm) or *portoricensis* (wing, 270–286 mm). Darker than *flammeus* and *sandvicensis*, and much darker than *brennauis* and *sanfordi*, but not as dark as *galapagoensis*. In general coloration it somewhat resembles *bogotensis* Chapman, which has about the same length of wing, but a longer tail (140–148 mm.) and culmen; it differs from *bogotensis* by the lighter upperside; feathers on forehead, crown, and hind neck with broad ochraceous edges; feathers of back and scapulars with narrow ochraceous edges, whereas in *bogotensis* some of these feathers are almost uniformly brown; pattern in

¹Previous papers in this series comprise American Museum Novitates, Nos 115, 124, 149, 322, 337, 350, 356, 364, 365, 370, 419, 469, 486, 488, 489, 502, 504, 516, 520, 522, 531, and 590

the wing reduced as in *bogotensis*, but tail not as dark and no black streaks on feathers of tarsus. I cannot see any difference in coloration between *flammeus* and *sandvicensis*, but the Hawaiian birds run smaller on the average. In comparison with *flammeus* (and *sandvicensis*) the blackish shaft-streaks on the upperside are much broader and the ochraceous edges reduced; the black bands on the tail are much broader, and the wing-coverts much darker; the feathers of the tarsus are not streaked, but the under tail-coverts, which are uniformly colored or only faintly streaked in *A f flammeus*, have broad shaft-stripes; the under wing-coverts are heavily spotted, while they are usually immaculate in *flammeus*; dark marks on wing much enlarged; lower part of primaries dark brown without or with greatly reduced light bars; outer edge of first primary dark brown in lower third, without light bars; large light field on the base of the first primary crossed by a broad dark bar, which in *flammeus* is usually greatly reduced or missing.

	WING	TAIL	CULMEN	TARSUS
2 ♀ ad	295, 307	135, 139	17 0, 17.5	48, 51 mm.
RANGE—Ponape Island, Caroline Islands				

This bird was originally considered a straggler from Siberia, but Kubary found it breeding and collected the eggs, as reported by Finsch (1880. Journ f Ornith., p 283, and 1881, Ibis, p 113).

Mr Coultas fully confirmed the breeding status of the Ponape short-eared owl; in fact, the two females that he collected have enlarged ovaries with small yellow eggs. It is therefore not surprising that this bird does not agree with the Holarctic race.

Mr Coultas writes about this bird as follows:

There are at least two dozen or more owls on Ponape but those are very difficult to obtain.

After 5 o'clock in the evening, they put in their appearance over the grassland of the islands. In the twilight and on moonlight nights one can see them flying very low over the top of the grass and small bushes searching for rodents, etc. One hears their cat-like call at all hours of the night, except in rainy weather, when they are silent. They hide very successfully during the daytime. One never sees them. I was never able to flush one during the day, though I spent many hours in the grass patches and forest close by looking for finches.

The bird is startled easily and runs away from the slightest sound. Once frightened, it does not return again the same night.

My Ponape guide and self picked out a good grass patch of about 200 acres in size and visited this in the evening at sun-down. There we remained, at different times, until 9 to 11 P.M., in hopes that we could obtain specimens. On two different occasions, I obtained single shots (misses), which frightened the birds and spoiled the business at hand.

We tired of this and went at the matter with persistence. At one side of the field, where the grass was shortest, we cut a swath about 100 yards long by 40 feet wide, in an easterly and westerly direction, and burned off all of the grass. Near the easterly end, in a clump of bushes, we built a blind that sheltered us and at the same time gave us a good view of the runway looking toward the western twilight-lit heavens.

The first night after our runway was completed, I obtained a female and two nights later I obtained another female. The completion of other series and a stretch of rainy weather finished my nocturnal adventures . . .

Ponape name, Lu goat. The native god of the bush and mountain regions. It is still revered by the older people.

The species was also reported from Guam, Marianne Islands, by Freycinet, Quoy, and Gaimard of the Uranie Expedition. The specimens are, however, no longer in the Paris Museum, and there is a strong suspicion that the locality was wrongly reported, just as that of many other specimens of that expedition (see Oustalet, 1895, *Nouv Arch Hist Nat. Paris*, (3) VII, p. 168).

The same shipment of the Whitney South Sea Expedition from Micronesia also contained a series of *Hypotaenidia philippensis* from the Palau Islands. Knowing the strong tendency toward geographical variation in this species, I did not believe that the Palau birds were identical with those from the Philippine Islands, as hitherto accepted. A series of four fine specimens from the Philippine Islands, kindly loaned to me by Dr. Herbert Friedmann of the United States National Museum (Washington), revealed at once the distinctness of the Palau Island birds. I wish to thank Dr. Friedmann for his assistance in this matter.

***Hypotaenidia philippensis pelewensis*, new subspecies**

TYPE —No. 331885, Amer. Mus. Nat. Hist.; ♂ ad; Palau Islands, October 15, 1931; William F. Coultas.

SUBSPECIFIC CHARACTERS —A small, dark form, with the pectoral band usually present. Has nothing to do with *philippensis* which is a very light bird and of slightly larger size. Differs from *philippensis* by having a large rufous area in the nape (feathers frequently with fuscous tips, but without fuscous shaft-streaks); by having the light edges of the feathers on back, scapulars, and rump narrower and darker (the black centers of said feathers broader and much more conspicuous); and by having the white spotting on the upperside more pronounced, this being most obvious on the upper back and the upper tail-coverts; the underside is much clearer, lacking the dirty, buffy tinge of most specimens of *philippensis*. The breast-band is well developed in most specimens, and the black barring on breast and flanks much darker and more pronounced than in *philippensis*. In many ways rather similar to *H. ph. chandleri* Mathews, but differing from the Celebes bird by smaller size (average of wing in adult males 135 against 142); by the presence of a pectoral band; by having the upperside still darker with the ochraceous-gray edges of the feathers narrower; by having no spotting on the rump and less on the upper tail-coverts; by having the white marks on the upper back more frequently in the form of bars instead of spots; and by having the black bars on outer webs of the primaries broader (they are in this form usually broader than the alternating rufous bars, while in *chandleri* and most other forms they are of the same width or narrower). Differs from New Guinea birds by smaller size, and from birds of the Bismarck Archipelago (*lesoueffi* and *meyeri*) by

the lighter coloration of under and upper parts, and by the ochraceous gray, not dark brownish, edges of the feathers of the upperside

	WING	TAIL	BILL ¹	TARSUS
12 ♂ ad.	127-143 (134.6)	54-65 (60)	25-29 (27.7)	41-46 (43.5)
3 ♀ ad.	129, 136, 136	56, 57, 58	23, 24, 25	40, 41, 42

RANGE —Palau (=Pelew) Islands, Micronesia

Palau Islands birds of this species have been usually named binomially *Hypotaenidia philippensis*, or else referred to the Philippine Islands subspecies *philippensis*. Only Mathews in his review of the species appears to have noticed the difference ('Birds of Australia,' I, p. 199). He compares a single specimen from the Palau Islands with a New Guinea bird and states that it differs by the absence of a pectoral band. This must have been an exceptional specimen. Among the twelve adult males before me, six have a well-developed pectoral band and six have a diffuse or interrupted band; among four adult females two have the breast-band broadly developed, one bird has indications of a breast-band, but it is entirely missing in one. In a series of sixteen adult birds from the Palau Islands the pectoral band is thus absent in only one specimen.

This species is rather rare on the Philippine Islands, and it may be opportune to add a few remarks about the four specimens from Luzon, loaned by the U. S. National Museum, in reference to the description of the race *philippensis* as given by Mathews ('Birds of Australia,' I, p. 196). Although Mathews points out some of the actual peculiarities of this race, such as the reduction of the reddish patch on the hind neck and of the white pattern on the upper parts, the indistinctness of the barring of the under parts, and the dusky coloration of the lores, he mentions other characters which I can not confirm. The primaries are decidedly longer than the secondaries in all four skins before me, not shorter as stated by Mathews. The tail frequently shows some white marks, and there is some white spotting on the upper tail-coverts of all the specimens, though it is much less than in most subspecies. The breast-band is entirely missing in only one of the birds, but is diffusely developed in the other three. The main character, as compared with the neighboring races, is the paleness of the bird from the Philippine Islands.

SPECIMENS EXAMINED

H. ph. philippensis —Philippine Islands. Luzon, 2 ♂ ad., 2 ♀ ad.²

H. ph. pelewensis —Palau Islands. 12 ♂ ad., 4 ♀ ad., 2 imm.

H. ph. chandleri.—Celebes: 5 ♂ ad., 3 ♀ ad., 1 imm.

Also considerable material from the Papuan and Polynesian Region

¹From the lateral termination of feathering to the tip

²U. S. National Museum

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THE DEVELOPMENT OF THE UROSTYLE IN *UMBRA* *PYGMAEA* (DE KAY)

By C. M. BREDER, JR.¹

In a study of the life history and habits of the mud-minnow, *Umbra pygmaea* (De Kay), the manner of development of the urostyle was found to be of more than passing interest.² So different is it from fishes to which *Umbra* otherwise shows affinities, that it can only be compared with the ganoid *Lepisosteus* in this respect. Ryder, 1886, also noticed this but apparently had scanty material or did not recognize the extent of the development in *Umbra*. His remarks will be discussed at another point.

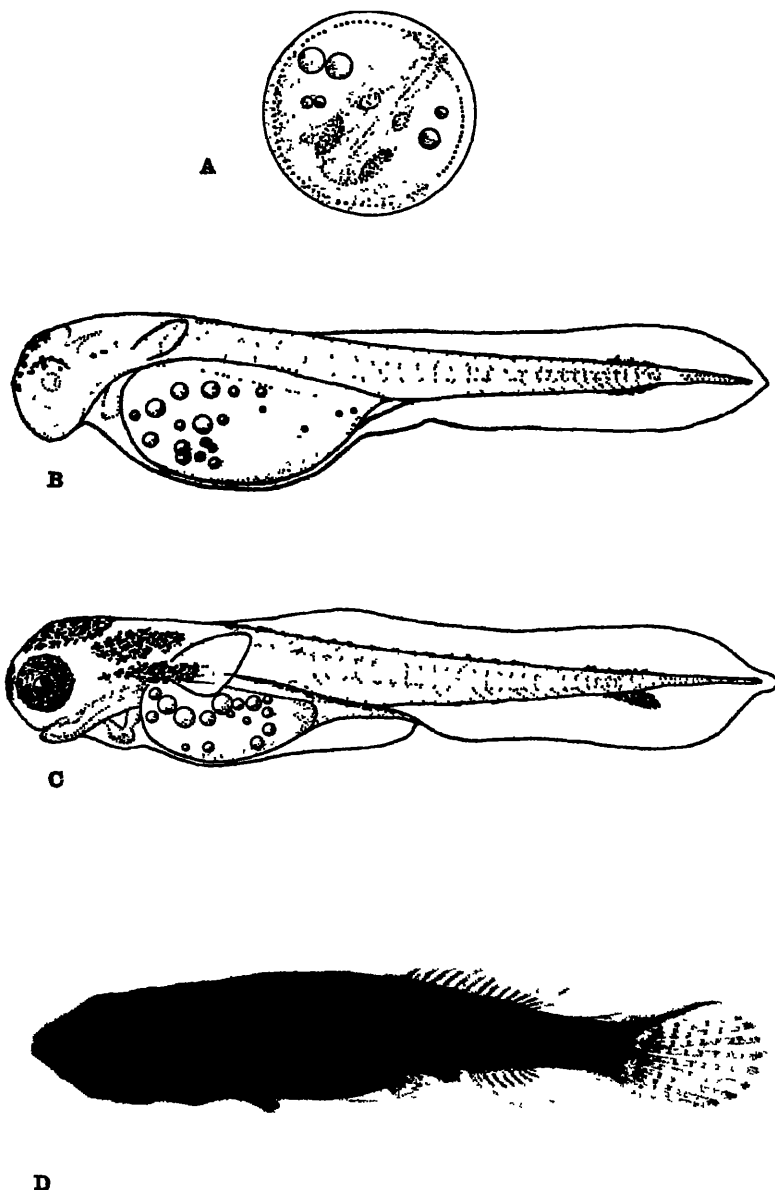
Among the teleosts that in the adult stage show an externally homocercal tail,³ there is a rather regular extent and sequence of development of the caudal extremity. This development may be characterized as follows. First, the embryonic protocercal condition of the caudal extremity is replaced by a more or less marked upward deflection of the tip of the chorda. Coincident with this, or more generally a little later, the hypochordal fin-rays, destined to remain as the permanent tail-fin, begin to appear. With their full development, or more frequently before, the urostyle relatively retracts so that by the time the permanent rays have reached their full development, or before, there is no longer any trace of external heterocercy. That is to say, that at this stage the tail is as fully homocercal externally as in the adult.

The preceding outline of developmental sequence and extent of development, however, is not followed by *Umbra*. A brief description of the salient features in the development of this exceptional urostyle follows. The egg and very early larval development is typical of the group with which *Umbra* is associated and may be considered quite normal up to the time that the chorda begins to deflect upward. These early stages are illustrated in figure 1. As the dorsal deflection sets in, the prolongation of that part destined to be urostyle is extreme. Simultaneous with this inclination from the vertebral axis and elongation is the develop-

¹Of the New York Aquarium, Research Associate in the Department of Ichthyology.

²The material on which this study is based was gathered at various localities within a radius of twenty-five miles of New York City and is deposited in The American Museum of Natural History.

³These include all those but the ganoids of the older classification; that is, the sturgeons, paddle-fishes, garpikes and bowfins, all of which show external heterocercy.



D
 Fig. 1. Early development of *Umbra pygmaea*. A, egg a day before hatching, 1.6 mm. diam.; B, newly hatched larva, 5.4 mm. total length; C, larva three days old, 6.0 mm. total length; D, post-larva, 14.5 mm. total length.

ment of the hypoaxial permanent fin-rays. The outline of the larval fin-fold follows the contour of these developing structures much more closely than is usual in other fishes. As development proceeds there is no relative recession into the interior of the body on the part of the urostyle, but it goes on developing, approximately equally with the rest of the fish. After the permanent fin-rays have reached their full development, the urostyle still exists as an external structure, above the tail-fin proper, free from it, and margined by its own membrane. This development, approximately, reaches its maximum when the fish is a little over 1.5 cm. in total length. After this size is passed the external urostyle begins to shrink so that at a total length of about 3.0 cm. it is entirely interior and the homocercy of the tail is externally complete. This manner of development is illustrated by the series comprising figure 2. At the time the external urostyle is most fully developed the young *Umbra* has already acquired its full adult appearance including coloration, form, and behavior. At this time the resemblance is so close as to make it entirely recognizable on sight.

Neither *Esox masquinongy* Mitchell, nor *Esox niger* LeSueur, nor any one of the numerous poeciliids and cyprinodonts well known to the writer, shows any such structure in its development. On the other hand *Lepisosteus osseus* (Linnaeus) does show a development bearing a rather close resemblance to the present. In *Lepisosteus* the external portion of the notochord is still larger and never "shrinks" to within the peduncle but remains as a permanent but adnate margin to the upper caudal fin-ray. See Agassiz, 1879, and Fish, 1932, for figures of development, and Kolliker, 1859, for a dissection of the adult tail.

The relatively slight flattening of the hypurals in the adult (Fig. 2F) presents a condition rather similar to that shown by *Esox*, as would be expected on a basis of the general similarity of these two genera.

A somewhat similar case is reported by Meinken, 1927, who describes and figures what he considers to be an adipose fin in the young stages of *Nannostomus anomalus* Steindachner. This structure, Myers, 1928, actually appears to be a remarkably developed urostyle. Although this characin is neither related nor especially resembles *Umbra* it is odd that both habitually strike a similar peculiar pose when resting; that is, they usually rest with the body axis slanted from the horizontal with the head up in a strikingly characteristic manner.

Ryder, 1886, wrote of *Umbra*: "Immediately after hatching it is observed that there is a small projecting lobe at the end of the tail. Into this lobe the notochord extends. This terminal lobe of the tail is

much narrower than the portion of the caudal lobe just in advance of it. As development proceeds it also becomes longer and more conspicuous. This terminal lobe of the tail of the larval mud-minnow is clearly homologous with the *opisthure* of the larval *Lepisosteus* and the adult *Chamaea monstrosa*. It is certain that it is subsequently absorbed, since the more advanced stages prove that the rays of the permanent caudal fin are developed far in advance of the opisthural lobe above described.

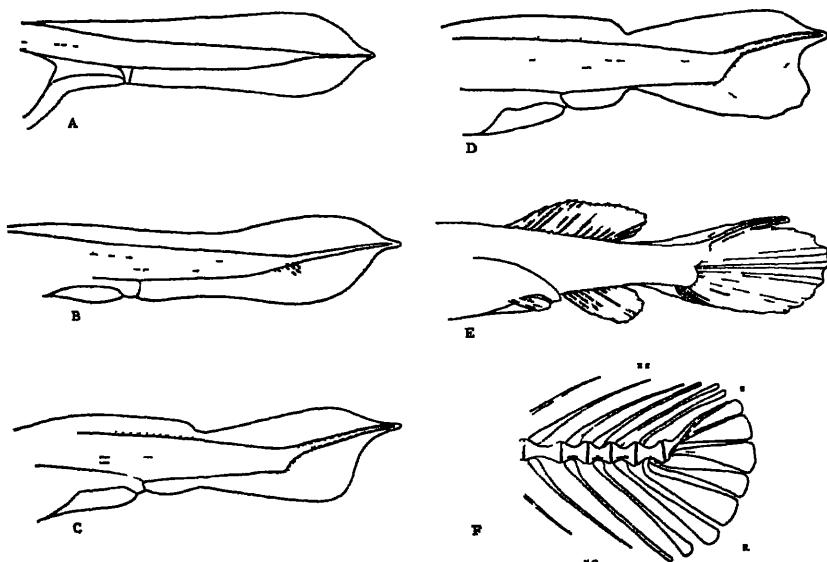


Fig. 2. Development of the tail of *Umbra pygmaea*. Camera-lucida drawings. Measurements represent total length of the fish

A, 4.75 mm, B, 6.5 mm, C, 8.5 mm, D, 10.0 mm, E, 15.0 mm
F, 45.5 mm, adult, skeletal parts with fin rays removed. H, hypurals, H, S, haemal spines, N, S, neural spines, U, urostyle, V, vertebral column

"There is a slight tendency to form an opisthural lobe in the larva of the pike, but the larva of none of the teleostean forms hitherto studied approach the Rhomboganooids so closely in respect to the manner in which the tail is developed as *Umbra*."

The "slight tendency to form such a lobe" on the part of *Esox* is certainly no greater than that of numerous other fishes but differs distinctly from *Umbra*, as already pointed out, especially in regard to the relative rates and times of development of the urostyle fin-rays. Nor is it clear that this structure "is homologous with the opisthure of larval *Lepisosteus*."

Whether this development can be considered as a retention of a primitive character, or a new specialization of possibly some functional significance, can only be determined by further study probably including histological examination and experimental procedure.

The resemblance of *Umbra* to *Amia* has been noted by Hildebrand, 1923, but is certainly nothing more than the incidental convergence of unlike forms occupying similar environmental places. This similarity of habitus prompted a comparison with the figures of *Amia* given by Dean, 1896. These at once show that this ganoid develops no such exaggerated urostyle as is present in either *Umbra* or *Lepisosteus*. Although there is a slight permanent external heterocercy the urostyle of *Amia* is small and ceases to be a protruding element before the permanent caudal rays fully develop and, so far as this feature goes, follows the generalized development of teleosts much more closely than does *Umbra*.

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ERYCINIDAE AND LYCAENIDAE (LEPIDOPTERA, RHOPALOCERA) FROM THE REGIONS OF MT. RORAIMA AND MT. DUIDA

BY E. IRVING HUNTINGTON

This is a report on material collected by Mr. G. H. H. Tate in the course of two expeditions to northern South America under the auspices of The American Museum of Natural History. The Lee Garnet Day Expedition was made in the latter part of 1927 and extended into early January, 1928, visiting Mt. Roraima, which lies at the junction of the boundaries of Brazil, Venezuela, and British Guiana. The Tyler Duida Expedition was undertaken during the latter part of 1928 and the beginning of 1929, its objective being Mt. Duida in southern Venezuela. Descriptions of both these regions are to be found in The Geographical Review for January, 1930.¹

The expedition to Mt. Roraima brought back five species of Erycinidae and an equal number of species of Lycaenidae. The Mt. Duida Expedition furnished sixteen species of Erycinidae and eleven species of Lycaenidae.

The Hesperidae collected by Mr. Tate on these two expeditions have been reported upon by Mr. E. L. Bell, in American Museum Novitates, No. 555, and the Pieridae are the subject of a paper by Mr. F. Martin Brown, in American Museum Novitates, No. 572.

LEE GARNET DAY EXPEDITION TO MT. RORAIMA

BRAZIL

Paulo.—Ten miles southwest of Mt. Roraima. Altitude, 4000 feet.

Arabupu.—Ten miles southeast of Mt. Roraima. Altitude, 4200 feet. Savannas.

Upper Swamp Camp, Mt. Roraima.—Altitude, 5800 feet.

Summit of Mt. Roraima.—Altitude, 8600 feet.

BRITISH GUIANA

Anundabaru.—At the headwaters of the Copenang River, one hundred miles east of Mt. Roraima. Altitude, 2000 feet.

¹Tate and Hitchcock, 'The Cerro Duida Region of Venezuela,' XX, pp 31-52, and Tate, 'Notes on the Mount Roraima Region,' XX, pp 53-68.

Tuket.—On the Potaro River. Altitude, 2000 feet

ERYCINIDAE

Euselasiinae

Euselasia artos Herrich-Schäffer

Paulo, Brazil, November 5, 1927, 1 male

RANGE.—Bolivia, Surinam, and the Amazon region.

Erycininae

Mesosemia parishi Druce

Arabupu, Brazil, December 26, 1927, 1 male.

RANGE.—Colombia, the Guianas, and the Amazon.

Mesosemia philocles Linnaeus

Anundabaru, British Guiana, January, 1928, 1 male.

RANGE.—The Guianas and the Amazon.

Nymphidium baetia Hewitson

Tuket, British Guiana, January, 1928, 2 females.

Anundabaru, British Guiana, January, 1928, 1 male.

RANGE.—The Guianas and the Amazon region.

Nymphidium cachrus Fabricius

Anundabaru, British Guiana, January, 1928, 3 males.

RANGE.—Colombia, the Guianas, and the Amazon region.

LYCAENIDAE

Theclinae

Thecla linus Fabricius

Arabupu, Brazil, December 26, 1927, 1 male.

Anundabaru, British Guiana, January, 1928, 4 males.

RANGE.—Colombia, Venezuela, the Amazon, and Bolivia.

Thecla abola Hewitson

Upper Swamp Camp, Mt. Roraima, October 28, 1927, 1 female.

RANGE.—Mexico, Colombia, Venezuela.

Thecla beon Cramer

Arabupu, Brazil, December 26, 1927, 1 female.

Summit of Mt. Roraima, November 27, 1927, 2 females.

RANGE.—Central and South America as far as southeastern Brazil.

***Thecla crethona* Hewitson**

Arabupu, Brazil, December 26, 1927, 1 female.

RANGE.—Seitz ('Macrolepidoptera of the World,' V, p. 799) gives the range of this species as being Cuba and Jamaica. The writer is unaware of any other records from so far south as Brazil.

Lycaeninae***Leptotes cassius* Cramer**

Tukeit, Potaro River, British Guiana, January, 1928, 1 female.

RANGE.—Mexico and the West Indies to Argentina. Widely distributed and generally common.

TYLER DUIDA EXPEDITION**ERYCINIDAE****Euselasiinae*****Euselasia erythraea* Hewitson**

Mt. Duida, Venezuela, November 15, 1928, 1 male.

RANGE.—Colombia and the Amazon.

***Euselasia euphaes* Hewitson**

Mt. Duida, Venezuela, November 12, 1928, 1 male.

RANGE.—Throughout the entire Amazon region.

Erycininae***Eurybia nicaea* Fabricius**

Mt. Duida, Venezuela, November 14, 1928, 1 female.

Rio Negro, Brazil, September 19, 1928, 1 male.

RANGE.—Ecuador, Colombia, the Amazon region to southern Brazil.

***Mesosemia menestes* Hewitson**

Rio Negro, Brazil, September 19, 1928, 2 males.

RANGE.—Bolivia, the Guianas, and the Amazon region.

***Mesosemia cippus* Hewitson**

Mt. Duida, Venezuela, November 23, 1928, 1 female.

RANGE.—Colombia and the Guianas across the Amazon region to Peru, Bolivia, and central Brazil.

***Alesa amesis* Cramer**

Mt. Duida, Venezuela, November 24, 1928, 1 male, 1 female.

RANGE.—The Guianas and the Amazon region.

***Riodina lysippus* Linnaeus**

Rio Negro, Brazil, September 5, 1928, 1 female.

RANGE.—Colombia, Venezuela, the Guianas, and the Amazon

***Diorina periander* Cramer**

Mt. Duida, Venezuela, November 24, 1928, 1 male.

RANGE.—Mexico, Central and South America as far as Bolivia to the west and southern Brazil to the east.

***Mesene phareus* Cramer**

Mt. Duida, Venezuela, November 12, 1928, 1 male.

RANGE.—Bolivia, Colombia, Venezuela, and the Guianas.

***Anteros formosus* Cramer**

Mt. Duida, Venezuela, March 5, 1929, 1 male.

RANGE.—From the northern coast of South America to southern Brazil and Peru.

***Charis gynea zama* Bates**

Mt. Duida, Venezuela, November 23, 1928, 2 females.

RANGE.—Amazon region.

***Lemonias luciana* Fabricius**

Mt. Duida, Venezuela, September 19, 1928, 1 male; November 14, 1928, 1 male.

RANGE.—Panama, Venezuela.

***Echenais aristus* Stoll**

Mt. Duida, Venezuela, November 23, 1928, 1 female.

RANGE.—Surinam.

***Echenais leucocyana* Hübner-Geyer**

Mt. Duida, Venezuela, November 12, 1928, 1 male.

RANGE.—The Guianas and the Amazon region.

***Nymphidium basotia* Hewitson**

Mt. Duida, Venezuela, November 14, 1928, 1 male.

RANGE.—The Guianas and the Amazon region.

***Nymphidium mantus* Cramer**

Mt. Duida, Venezuela, November 14, 1928, 2 males.

RANGE.—Venezuela and the Guianas to Brazil.

LYCAENIDAE**Theclinae*****Thecla atys* Cramer**

Mt. Duida, Venezuela, November 24, 1928, 1 male.

RANGE.—Panama and Colombia.

***Thecla color* Druce**

Mt. Duida, Venezuela, November 23, 1928, 1 male.

RANGE.—The Guianas.

***Thecla beon* Cramer**

Mt. Duida, Venezuela, November 23, 1928, 1 female.

RANGE.—Central and South America to southeast Brazil.

***Thecla atrius* Herrich-Schäffer**

Rio Negro, Brazil, September 12, 1928, 1 male.

RANGE.—Guatemala to the Amazon.

***Thecla vesulus* Cramer**

Mt. Duida, Venezuela, March 5, 1929, 2 females.

RANGE.—The Guianas to the Amazon.

***Thecla anthora* Hewitson**

Mt. Duida, Venezuela, March 5, 1929, 1 female.

RANGE.—The Guianas to the Amazon.

***Thecla cerata* Hewitson**

Mt. Duida, Venezuela, March 5, 1929, 1 female.

RANGE.—Guatemala to the Amazon.

***Thecla celmus* Cramer**

Mt. Duida, Venezuela, November 24, 1928, 1 female.

RANGE.—Mexico to southern Brazil.

***Thecla ceromia* Hewitson**

Rio Negro, Brazil, November 19, 1928, 1 female.

RANGE.—Bolivia and the Amazon region.

***Thecla basalides* Hübner**

Mt. Duida, Venezuela, February 7, 1929, 1 male.

RANGE.—Widely distributed from Mexico to southeastern Brazil.

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REPRODUCTION AND EGGS OF *POMACENTRUS LEUCORIS* GILBERT

BY C. M. BREDER, JR., AND C. W. COATES¹

On May 2, 1930, twenty-six specimens of *Pomacentrus leucoris* Gilbert collected at the Galapagos Islands on the first 'Nourmahal' expedition² were brought to the New York Aquarium by Mr. Vincent Astor.

This species is at least as quarrelsome in the relatively close confines of an aquarium as its better-known Atlantic relatives, and as a result of this disposition the twenty-six specimens were reduced to two by the beginning of 1932. Even the placing of a relatively large species (*Spheroides maculatus* Bloch and Schneider) in the aquarium caused such strong resentment that it was necessary to remove the latter in the interests of peace.

The two fishes that remained proved to be of opposite sex, and with the aquarium (4' X 3' X 3½' deep) to themselves they soon engaged in egg-laying. As there is little recorded on the reproduction of the Pomacentridae, and since there is little likelihood of further observations being made on this species in the near future, the reproductive behavior and the physical appearance of the peculiar eggs are here discussed.

The actual courtship and "nest building" may be described as follows. Both fishes were observed carrying mouthfuls of sand to a protuberance of rock in the aquarium and blowing it out in a cloud so that some of the sand settled on the rock, and the rest rolled off. After several mouthfuls of the sand had been carried up in this manner, from the floor of the aquarium, the fishes "fanned" vigorously with their fins, and then with their mouths picked off the few remaining grains of sand from the rock. After several efforts of this kind, they abandoned this site and chose another jutting ledge of rock which was treated to a similar scouring of sand. This, too, proving unsatisfactory, still other sites were selected until a dozen or more had been tried before one was found to suit. All of these abandoned sites were plainly visible for a short while, since traces of sand were left at each one.

¹Of the New York Aquarium.

²See Townsend, C. H., 1930, Bull. N. Y. Zool. Soc., XXXIII, No. 4, for details of this expedition.

The place finally chosen for the eggs was treated in the same manner, but the sanding and fanning were carried on for several hours, each fish working industriously all the while. One fish, however, seemed to show more activity than the other; this probably was the male. After the surface of the rock had been thoroughly cleaned, the female swam over it with her ventral surface touching the face of the rock, and the ovipositor plainly in view. She left a more or less concentric circle of eggs adhering to the rock over which the male swam, following the female very closely both in time and movement. The eggs were deposited during a number of spawnings, each taking from ten to thirty minutes to complete, with a varying length of time between. These intervals of rest between the spawning ranged from a few minutes to several hours and seemed to be acceptable to both the male and female, although, at these times, the fish were excited and restless, continually darting about the tank.

Owing to its distance from the glass wall, it is not possible to say how many eggs were deposited in the nest, either for the total, or for each actual spawning period; but, from a comparison of an egg to the space covered, the entire number approximated four or five hundred.

The above-mentioned ovipositor protruded about one-eighth of an inch and was about the same in diameter, or a very little larger. It was white and flat at the end, and may be nothing more than the lips of the genital pore pressed outward by the mass of eggs within. The male fish exhibited a similar structure, except that it was not so wide and was pointed at the end. The point was slightly inclined toward the head of the animal. Whether this is not a necessary protrusion, or whether the fishes swam at a slight angle occasionally, this protuberance was not always visible during the spawning.

After the eggs were once deposited, the care of them was not unlike that exhibited by a variety of other fishes that circulate water for such purposes. This process has already been briefly described and illustrated with two photographs, but it may here be expanded in greater detail. The photographs published in the former article¹ show the second spawning; illustrations in the present paper picture the third spawning.

Both fish were in constant attendance on the eggs, one of them usually immediately above the egg-covered rock, the other hovering nearby. They moved with quick jerky darts to one side or the other. The fish above the eggs continually fanned them, particularly with the pectoral fins. This fanning seemed to rock the fish in a peculiar lateral

¹See Breder, C. M., Jr. 1932. *Bull. N. Y. Zool. Soc.*, XXXV, No. 4, pp. 120-121.



Fig 1 *Pomacentrus leuconis* in two typical postures while tending its eggs
Photographs by S C Dunton

motion. If one fish left the eggs, the other almost immediately took its place. While correct identification of the sex of the fish was not always possible, the male was apparently most active in the care of the spawn. Occasionally the fish in attendance would pick over the spawn, seemingly sorting out unfertilized or dead eggs.

In all, three batches of eggs are known to have been deposited be-

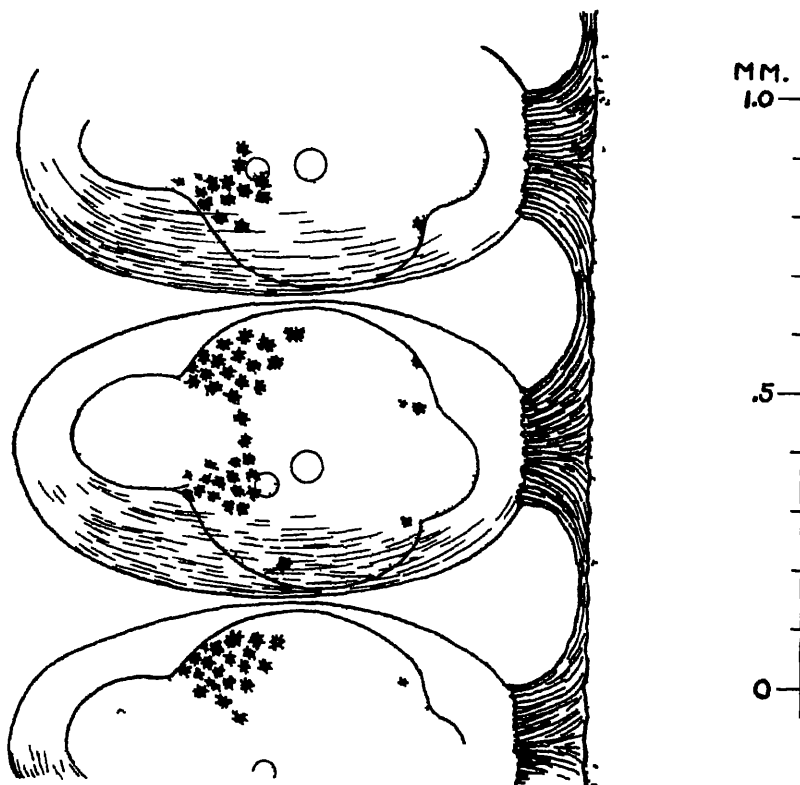


Fig 2 Eggs of *Pomacentrus leucoris*, fifty-one hours after spawning, showing attachment to a vertical surface. Semi-diagrammatic.

tween early spring and August 13, indicating a considerable gonadal activity on the part of these fishes. As is not uncommon with such animals, in captivity at least, the first two batches were eaten by their parents on the following day. To forestall this the parents were removed after the third spawning¹. This occurred at 11 00 A M., August 13, and

¹Unfortunately one died apparently as a result of an accident in handling which forced a termination to this study.

it forms the chief basis of the preceding description of spawning behavior. On the 15th a few of the eggs were removed for examination. Their condition at 2:00 P.M., fifty-one hours after spawning, at a temperature of 72° F., is shown in figure 2 and indicates the well-advanced condition of the embryos. These eggs may be described as follows: they are evenly elliptical in form, the long axis not quite twice that of the short, the former ranging from about 0.8 to 0.9 mm. with an average a little over 0.85, the latter ranging from about 0.4 to 0.5 with an average a little over 0.45. The surface of the shell is entirely covered with fine longitudinal striae, as indicated in figure 2. At this stage there is no evident perivitelline space. The yolk, principally about the head-end, is freckled with black chromatophores, thus forming something of a "collar" about the embryonic "throat" region. The yolk is slightly tinted with amber, which hardly differentiates it from the somatic portions. The oil-globules, usually two in number, unlike those of most fish-eggs, are either colorless or exactly match the pale yolk. Viewed by transmitted light the oil globules are less refractive than any others known to us.

The most striking feature of these eggs is their method of attachment. From one pole numerous closely packed tendrils depend, which in a single detached egg resemble somewhat the condition found in *Menidia*. However, when a group of eggs is examined, it becomes apparent that these tendrils are so interlaced, or continuous, that each egg is connected with its neighbor. Thus each egg stands on a small pedestal when the common footing is applied to a flat surface. So far as this feature is concerned, figure 2 is a semi-diagrammatic reconstruction showing how the eggs were originally attached to their rock-support. The eggs are very evenly spaced, and it will be noted that they are almost, but not quite, in contact with one another. As these eggs were attached to a vertical wall and not tilted either upward or downward, except as originally described when a parent fanned them, it follows that they must have substantially the specific gravity of the water in which they were immersed.¹

The head of the embryo in each egg examined was directed away from the base. The eggs removed for examination failed to hatch. Those in the aquarium hatched on the 17th. The larval fish could be seen moving about near the broken shells. In a few days none were to be seen. The reason for this we were unable to ascertain.

¹For other reasons not concerned with this study the specific gravity was carried unusually high (1.0297).

It is known that the Atlantic species *Pomacentrus leucostictus* Muller and Troschel usually places its eggs in large empty shells, such as those of *Strombus*. Such nests are abundant in the shoal waters of the Dry Tortugas, Florida. Many were found here in the summer of 1929, at the laboratory of the Carnegie Institution of Washington. Although there were no shells present in the aquarium in which *P. leucoris* spawned, the rock-work on the walls provided a large choice of surfaces. Many cavities were large enough for the fishes to hide in completely; but none of these was selected for egg-laying, though each batch of eggs was placed on an exposed, approximately vertical rock, which presented a scarcely perceptible concavity. This is well illustrated in the photographs already published.¹ Very likely this difference in choice of nesting sites between *P. leucostictus* and *P. leucoris* is a real one and not merely induced by the condition of captivity.

¹Breder, *loc. cit*

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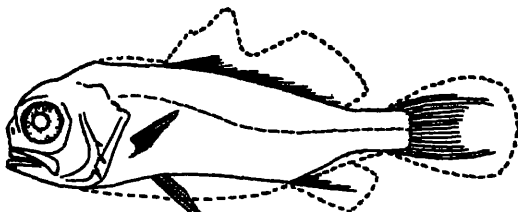
May 8, 1933

59 7, 58 B 12 93

A ROUND-HEADED SILVER PERCH, *BAIRDIELLA* *CHRYSTURA*; WITH NOTES ON THE EARLIEST FIGURED ROUND-HEADED FISH

By E. W. GUDGER

There is in the collections of the American Museum a young round-headed specimen of *Bairdiella chrysura* without any data as to its source. My attention was called to it by my colleague, Mr. J. T. Nichols, who identified and catalogued it. Since I have in recent years described a number of pug-headed fishes, and since this is a very closely allied deformity, I will now briefly describe this specimen also. To this account will be added the figure of and a brief note on the earliest recorded case of this deformity in fishes.



A.M.N.H. No 5171

Fig. 1. Lateral view of the little round-headed *Bairdiella chrysura* in the collections of the American Museum. The figure shows the fish in natural size—67 mm. over all.

Our specimen of *Bairdiella chrysura* has been in strong alcohol for years, is somewhat contracted and distorted in the abdominal parts, and is as hard as leather. However, the head has been little affected by this. Figure 1, drawn life size, shows the shrunken abdomen and the frayed fins. The head-parts have been drawn with great care and the figure shows them exactly as I see them in the specimen before me. For comparison's sake a normal young specimen of the silver perch of about the same stage of development as the deformed fish has also been drawn (Fig. 2 herein).

Now the body of the fish in Fig. 1 is little changed in length between any fixed points, excluding the snout. So taking as a standard

length the distance between the hinder point of the operculum and the end of the tail (the beginning of the caudal fin), the drawing reproduced in Fig. 2 has been reduced to the same length (38 mm.), between the same points, the head and tail being reduced in the same degree. Since the little fish in Fig. 2 is normal in every way, we can use its head as a standard of comparison for that of the teratological fish and can readily see how much deformation this has undergone

This abnormal fish, measured from the anterior point of the rounded head to the dorsal tip of the frayed caudal fin, is 67 mm. long. The unbroken tail as shown in the dotted line would have added about 3 mm. more, making the "over-all" length as it is drawn about 70 mm. However, had the snout been normal it would have added probably not more than 5 mm. to the total length. The over-all length of this specimen, if normal, would probably be about 75 mm. The depth in the shoulder

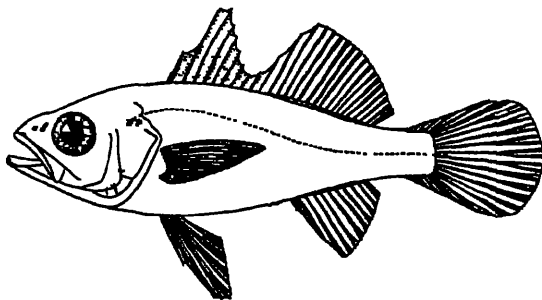


Fig. 2. Lateral aspect of a normal silver perch of about the same stage of development as the fish shown in Fig. 1. For comparison of head-parts, this drawing is reduced to the same length (operculum to base of caudal—38 mm.) as Fig. 1 between the same points. The head and the caudal fin are of course reduced proportionally.

After Hildebrand and Schroeder, 1928.

region is 18 mm, and this is probably fairly close to the normal depth in this deformed fish.

In pug-headed fishes the whole anterior part of the head including the upper jaw is shortened and the forehead of the fish falls abruptly off into the floor of the mouth, but the lower jaw remains intact—projecting in front like an old-fashioned Ames-made shovel. That this may be clear to the reader, a figure of a pug-headed brown trout (*Salmo fario*) is reproduced from a previous paper of mine. This fish, seen in lateral view in Fig. 3, should be compared with those shown in Figs. 1 and 2.

Figures 3 and 2 then emphasize very strongly what has taken place in the little silver perch. Not only has the anterior part of the head

failed to develop, but the lower jaw has likewise failed in exactly the same degree. The lower jaw is slightly longer than the upper—a mere fraction of a millimeter—but so it is in the normal young fish shown in Fig. 2, and also in the adult fish. In brief, the shortening of the head has taken place equally in both jaws, producing that deformity in fishes known as round-headedness.

Along with the shortening of the snout has come a marked humping up in the region over the eye and over the operculum. The shortening of the snout has brought the steep forehead close to the eye and has apparently reduced the nasal openings to one. Compare here the normal fish with the deformed one.

As to the causes of this deformity, one cannot speak with too much confidence. In the round-head as in the pug-head, it is clear that the

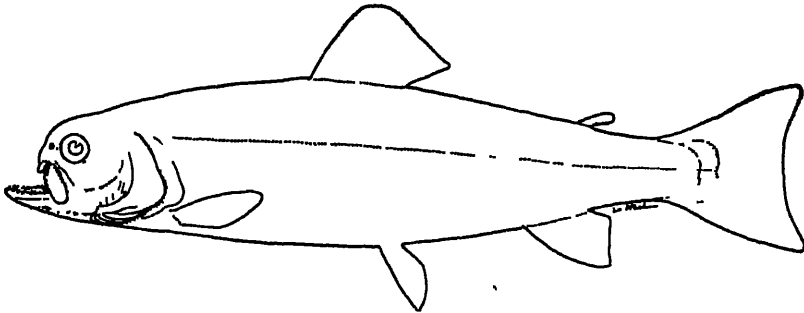


Fig 3. A pug-headed brown trout (*Salmo fario*) drawn to show the steep forehead and the fully developed projecting lower jaw.

After Gudger, 1920

basal bone of the skull, the parasphenoid, has failed to develop and the anterior part of the skull has failed to elongate. As a result of this developmental failure all the bones forming the anterior part of the skull have become tied down in front giving the snub-nosed appearance seen in Fig. 1.

In some pug-heads the parasphenoid buckles up into the space between the eyes causing these to bulge noticeably. This I found in a pug-headed sea-bass (*Roccus lineatus*) which I described some years ago. No exophthalmia is found in the silver perch under consideration.

For the shortening of the lower jaw, I have no particular explanation to offer. It has simply failed to develop along with the other parts of the head. However, for the whole head it may be said that it has remained in the embryonic condition. This explanation is offered because

it is well known that all embryonic fishes are round-headed. Hildebrand and Schroeder's figure (not reproduced herein) of an 11-mm. specimen of *Bairdiella chrysura* shows this very distinctly. The body and hinder two-thirds of the head of the teratological little silver perch developed, but the anterior part of its head never did—it remained in the embryonic condition. As to the cause of this retarded development, one can only conjecture that it was due to a failure in the hormonal balance. It is known that such achondroplastic disturbances (possibly a failure of the pituitary) in dogs bring about pug-headedness. Presumably the same thing holds for fishes.

Since this is presumably the latest round-head fish on record (March, 1933), it may be of interest to reproduce the earliest known figure of such a deformity and briefly to describe it.

This oldest account is found in Conrad Gesner's 'Liber III'

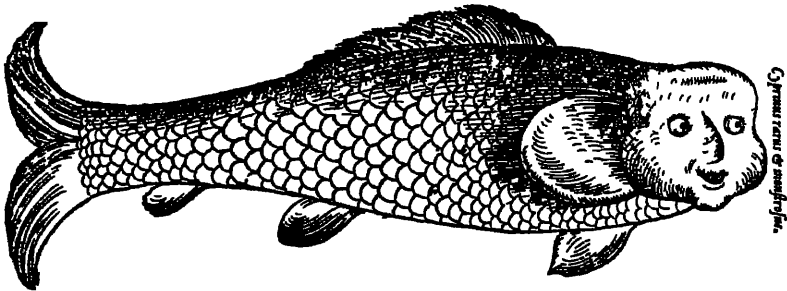


Fig. 4. Gesner's round-headed carp, the earliest published figure, in which the artist's imagination had free play.

After Conrad Gesner, 1558.

('De Piscium & Aquatilium Animantium Natura') of his encyclopedic 'Historia Animalium' (Tiguri, 1558). Gesner had seen Rondelet's figure of a pug-headed carp (1555—the first figure of such a fish ever published) and had data for four carp with abnormal heads; he had drawings of two of these fish, and had two specimens of these deformed fish, or their dried skins, which had been sent to him. Whether his specimens were pug-heads or round-heads cannot be said from his text. But his figure (No. 4 herein) would indicate that it was drawn from a round-headed specimen. Rondelet's figure is a well-drawn and scientifically valuable representation of a pug-headed carp. Gesner's drawing—in the making of which his artist took great liberties—is of interest from a historical and antiquarian standpoint only. It is apparently the first drawing ever attempted of a round-headed fish.

Few other round-headed fish have been figured and described. So far as known to me, these comprise: one other carp, a bream, a mullet, and three gadoids. I have photographs of such a round-headed codfish and of a pollack which I hope later to publish with descriptions. Apparently this deformity is more often found in the Gadidae than in fishes of any other family.

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THE NORTH AMERICAN SPECIES OF *ACTIA* IN THE AMERICAN MUSEUM OF NATURAL HISTORY

By C. H. CURRAN

A review of the North American species of *Actia* Desvoidy is presented in the following pages. The identification of species belonging to this genus has been difficult owing to the confusion existing in regard to the determination of the described species and the recognition of the genus *Thryptocera* Macquart. In this genus the presence or absence of bristles on the first vein is of no more than specific value and for this reason *Thryptocera*, or more correctly, *Ceranthia* Desvoidy, is not tenable. In *Actia* the bristles of the dorsum of the thorax are depressed and in all the species I have seen there are four pairs of postsutural dorsocentrals (Coquillett described *atripes* as having only three pairs); there are three sternopleural bristles, and the proboscis is at most slightly longer than the head and bears large labellae. In some exotic species the apical cross-vein is absent, while in others the third antennal segment of the male is greatly modified.

Unless otherwise stated the types of the new species are in The American Museum of Natural History.

Following is the generic synonymy in so far as reference to American species is concerned.

Actia Desvoidy

DESVOIDY, 1830, Mem. Acad. Roy. Sc. Inst. France, II, p. 85.

Ceromya DESVOIDY, 1830, Mem. Acad. Roy. Sc. Inst. France, II, p. 86.

Ceranthia DESVOIDY, 1830, Mem. Acad. Roy. Sc. Inst. France, II, p. 88.

Thryptocera MACQUART, 1834, Soc. Sci. Lille, (1833), p. 310.

Gymnophthalma LIOY, 1864, Atti Inst. Ven., (3) IX, p. 1341.

Polychætoneura WALTON, 1914, Proc. Ent. Soc. Wash., XI, p. 90.

The exact status of *Actia* Desvoidy must remain in doubt until the type species, *cingulata* Desvoidy, has been definitely identified. The designation of *cingulata* as type of the genus is most unfortunate as the species has not been recognized since its description and it may well be that it does not conform to our present conception of the genus. On the other hand *A. pilipennis* Desvoidy (not Fallén) is known to be a synonym of *lamia* Meigen. It is further significant that the genus was based on species lacking the apical cross-vein, a character possessed by

only a few forms now included. According to the original description of *A. cingulata* the veins are not bristled, a character not found in any of the known species at present included in the genus and it seems most likely that the recognition of *cingulata* will prove that *Actia* is not properly interpreted at the present time. However, I use the name pending more light on the question.

TABLE OF SPECIES

1.—Fifth vein bristled . . . . .	..	..	8.
Fifth vein bare . . . . .	. . . . .	. . . . .	2.
2.—First vein bristled on at least the apical section . . . . .	..	. . . . .	5
First vein bare . . . . .	..		3
3.—Legs yellowish			4.
Legs black		<i>atripes</i> Coquillett.	
4.—Penultimate arisal segment half as long as the terminal segment		<i>flavipes</i> Coquillett.	
Penultimate arisal segment not twice as long as wide . . . . .	..	<i>panamensis</i> , n. sp.	
5.—First vein bristled on apical section only		<i>palloris</i> Coquillett.	
First vein bristled beyond the humeral cross-vein. . . . .	. . . . .	. . . . .	..6.
6.—Abdomen with the sides very broadly yellow . . . . .	. . . . .	<i>ontario</i> , n. sp.	
Abdomen black, the segmental incisures at most very narrowly reddish			7.
7.—Abdomen shining except the very narrow segmental bases		<i>nitidiventris</i> , n. sp.	
Abdominal pollen extending to beyond the middle of the second to fourth segments. . . . .	. . . . .	<i>diffidens</i> , n. sp.	
8.—Abdomen black in ground color			9.
Abdomen very broadly reddish yellow laterally		<i>americana</i> Townsend.	
9.—Abdominal pollen sharply defined and occupying at most the basal third of the segments. . . . .	. . . . .	<i>interrupta</i> , n. sp.	
Abdominal pollen extending to beyond the basal half of the segments and not sharply defined . . . . .	. . . . .	. . . . .	10.
10.—Proboscis short, the labellae very broad. . . . .	..	<i>diffidens</i> , n. sp.	
Proboscis long and slender, the labellae slender and elongate; apical cross-vein absent in female. . . . .	. . . . .	<i>autumnalis</i> Townsend.	

Actia atripes Coquillett

Thryptocera atripes COQUILLETT, 1897, 'Rev. Tachinidae,' p. 58

A. atripes may be readily recognized by the absence of bristles on the first vein, black femora and yellow sides of the abdomen. I have not seen the species and apparently it has not been recorded since it was described from a single female from New Bedford, Mass.

Actia flavipes Coquillett

Thryptocera flavipes COQUILLETT, 1897, 'Rev. Tachinidae,' p. 58

Black and yellowish, the thorax thickly pollinose. Length, about 4 mm

FEMALE.—Face and cheeks yellow in ground color, the front and occiput black; frontal vitta reddish yellow. Front slightly longer than wide, with brownish-

yellow pollen except on the median vitta. Occiput with cinereous, the face and cheeks with white pollen. Apical section of proboscis about three-fourths as long as the head-height; cheeks one-fourth as wide as the eye-height. Antennae reddish, the third segment unusually large for a female and mostly brownish; arista practically bare, thickened on almost the basal three-fourths, the penultimate segment almost half as long as the apical.

Thorax black in ground color, cinereous pollinose, the humeri and scutellum yellowish, the latter more or less brown basally in the middle. Hypopleura with only one or two hairs in addition to the fine bristle.

Legs reddish yellow, the tarsi black; all the coxae pale.

Wings cinereous hyaline, first and fifth veins without bristles, the third bristled almost to the anterior cross-vein. Squamae large, whitish, with brownish tinge in some lights.

Basal two abdominal segments reddish yellow, the first with a wide median brown vitta, the second with a large, median blackish triangle; third and fourth segments black in ground color, the bases more or less yellowish. Abdominal pollen whitish, limited to the basal half of the second segment, extending to well beyond the middle on the third and fourth segments, dense basally on the segments, thinner apically because the hairs and bristles arise from bare spots. Venter much more extensively yellow.

Female, Station for the Study of Insects, Tuxedo, New York, July 5, 1928 (Curran)

Actia panamensis, new species

Mostly yellowish; first and fifth veins bare; front narrow. Length, 4.5 mm.

FEMALE.—Head yellow in ground color, the upper half of the occiput black; pollen white, yellow on the front and upper half of the occiput. Frontal vitta reddish yellow, darker posteriorly; front twice as long as wide; cheeks about one-twelfth as wide as the eye-height. Proboscis short, yellowish, the labellae larger. Palpi long and swollen. Antennae reddish yellow, the third segment mostly brown, three times as long as wide, arista brown, the penultimate segment little longer than wide.

Thorax yellowish, the disk of the mesonotum brownish in ground color; pollen yellowish on the dorsum, whitish on the pleura. Pteropleura with several hairs.

Legs yellowish, the tarsi blackish.

Wings cinereous hyaline, third vein bristled almost to the small cross-vein. Squamae whitish, with cinereous tinge. Halteres yellow.

Abdomen shining yellowish; second and third segments each with a median triangular blackish spot behind and a dark spot on either side, the fourth with an indistinct median triangle behind. Venter wholly yellow.

TYPE.—Female, Barro Colorado Island, Canal Zone, December 23, 1928 (Curran).

Actia palloris Coquillett

Lasioneura palloris COQUILLETT, 1895, Journ. N. Y. Ent. Soc., III, p. 50

Actia palloris COQUILLETT, 1897, 'Rev. Tachinidae,' p. 58

This species is wholly yellowish except for the brownish tarsi and brownish or blackish markings on the third and fourth abdominal segments. It is readily recognized by the absence of bristles on the fifth vein and their presence on only the apical section of the first vein. It is recorded from New Hampshire, Vermont, and Maine.

Actia ontario, new species

Thorax black, the abdomen partly reddish yellow; legs reddish yellow; first vein bristled on most of its length, the fifth bare Length, 4.5 to 5.5 mm

FEMALE.—Head yellow, upper three-fifths of the occiput blackish in ground color, the parafrontals brownish on the upper half; pollen whitish. Frontal vitta pale reddish yellow. Cheeks one-fourth as wide as the eye-height Proboscis reddish brown, the ultimate section not as long as the length of the head. Antennae reddish, the third segment tinged with brown on the apical half or more, more than half as wide as long; arista yellowish, with the apical third brown, thickened on the basal half, the penultimate segment about twice as long as wide

Thorax black in ground color, cinereous pollinose, the humeri and scutellum brownish yellow, the former sometimes black, the scutellum with a transverse black basal spot.

Legs reddish yellow, the tarsi darkened.

Wings cinereous hyaline First vein bristled beyond the humeral cross-vein, the bristles of equal length; third vein bristled to beyond the posterior cross-vein, the fifth bare Squamae white, halteres pale yellow.

Abdomen reddish yellow, sometimes with only a median brown vitta on the second and third segments, or with the fourth segment mostly blackish and the third with a black triangle extending broadly to the lateral margins behind and to the base of the segment in the middle, the second with median brownish vitta Pollen thin, whitish, occupying the basal three-fourths of the apical three segments, dense at the bases of the segments, the hairs and bristles arising from bare spots.

TYPES—Holotype, female, Norway Point, Lake of Bays, Ontario, July 31, 1919 (J. McDunnough), in Canadian National Collection. Paratype, female, Orillia, Ontario, June 12, 1925 (Curran).

Actia nitidiventris, new species

Black, the thorax cinereous pollinose; abdomen almost wholly shining; first vein bristled on its whole length Length, 5 mm.

FEMALE.—Head yellow, the upper two-thirds of the occiput and the parafrontals blackish in ground color; front and upper half of the occiput brownish yellow pollinose, the face and cheeks with white pollen. Front narrow, twice as long as wide; frontal vitta brownish red. Cheeks about one-sixth as wide as the eye-height. Proboscis brown, the apical section about as long as the length of the head; labellae large; palpi yellow, slightly enlarged apically. Antennae reddish, the third segment brown except at the base, three times as long as wide; arista thickened on the basal fourth, reddish on the basal third the penultimate segment but little longer than wide.

Thorax blackish or brown, cinereous yellow pollinose, the mesonotum with three broad, bare vittae in front; pleura with more or less reddish on the borders of the incisions; humeri and apical half of the scutellum reddish yellow.

Legs blackish, the coxae reddish brown, the anterior pair yellowish.

Wings cinereous hyaline, first vein with bristles of almost equal length beyond humeral cross-vein; third vein bristled to opposite the posterior cross-vein; fifth vein bare. Squamae with strong brownish tinge, the base and border white; halteres yellow.

Abdomen shining blackish, the tips of the first to third segments yellowish, the very narrow bases of the second to fourth segments whitish pollinose except in the middle, the ground color more or less yellowish beneath the pollen.

TYPE.—Female, Barro Colorado Island, Canal Zone, February 16, 1929 (Curran).

Actia diffidens, new species

Black, the abdominal pollen extensive but dense only on the basal fourth of the segments; first and third veins bristled, the fifth normally bare. Length, 4.5 to 5 mm.

MALE.—Head black in ground color, the face and cheeks, and sometimes the lowest sixth of the occiput, yellow; pollen cinereous, more whitish on the face and cheeks. Frontal vitta reddish yellow. Cheeks less than one-sixth as wide as the eye-height. Proboscis about as long as the head, the labellæ large; palpi yellowish, very slightly clavate. Antennæ reddish, the third segment mostly blackish, slightly more than twice as long as wide; arista thickened and brownish red on the basal half, black apically, the penultimate segment about four times as long as wide.

Thorax black, cinereous pollinose, the mesonotum with brownish tinge; apical border of the scutellum broadly yellowish.

Legs brown, the coxæ and tibiae reddish brown to reddish, the anterior coxæ always reddish.

Wings cinereous hyaline; first vein bristled beyond the humeral cross-vein, the bristles on the apical section finer and becoming shorter apically; third vein bristled to opposite the posterior cross-vein; fifth normally bare but sometimes with one or two inconspicuous bristles. Squamæ with yellowish tinge; halteres yellow.

Abdomen black, cinereous white pollinose; first segment, a broad median vitta and the broad apices of the segments bare; basal fourth or more of the second to fourth segments thickly pollinose; hairs and bristles arising from bare spots.

FEMALE.—Third antennal segment a little smaller and more extensively reddish. Palpi larger and more clavate; femora sometimes mostly reddish.

TYPES.—Holotype, male, Kentville, Nova Scotia, June 17, 1924 (R. P. Gorham); allotype, female, St. Peters, Nova Scotia, July 10, 1930 (M. L. Prebble), in Canadian National Collection. Paratype, female, Chatham, New Brunswick, August 15, 1926 (F. Johansen).

A. diffidens bears a strong superficial resemblance to *A. infantula* Zetterstedt but has the first vein bristled beyond the humeral cross-vein whereas *infantula* bears only short, fine bristles on the apical section and also has a narrower front. I have seen no specimens of *infantula* from America.

Actia americana Townsend

Thrypocera americana TOWNSEND, 1892, Can. Ent., XXIV, p. 69.

Actia phippenus COQUILLET, 1897, 'Rev. Tachinidae,' p. 59 (in part).

Polychaetoneura elyni WALTON, 1914, Proc. Ent. Soc. Wash., XI, p. 91 (figs.).

Thrypocera americana JOHNSON, 1925, Occ. Papers Bost. Soc. Nat. Hist., VII, p. 186.

A. americana is the only Nearctic species of *Actia* known to me having the fifth vein bristled and the sides of the abdomen yellowish. It is

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RECORDS OF AFRICAN BEES. II

By T. D. A. COCKERELL

The abbreviations used are the same as in Part I (American Museum Novitates, No. 547).

Euasps abdominalis (Fabricius)

Belgian Congo: Malela, July 9, 1915, ♀ (L. and C.). I have a specimen from Port Natal, from F. Smith's collection, which differs by the wholly black scutellum and the dark hair on hind legs, as well as other small features. This is *E. martin* Vachal, which Meyer (1921) regards as a variety of *E. rufiventris* Gerstaecker. Vachal's type came from "Cape Colony," probably actually from Natal. Smith included this in *E. abdominalis*. I have a genuine *E. abdominalis*, like that from the Congo, from Togo, Bismarckburg (R. Buttner). I am disposed to consider *E. martin* a valid species.

E. abdominalis was described (1793) as *Thynnus abdominalis*.

Euasps erythros (Meunier)

Belgian Congo: Faradje, Nov., 1912, ♀; Boma, June 15, 1915, ♂; Matadi, June 9, 1915, ♂ (all L. and C.). The female is easily known by the horseshoe-like elevation on the apical sternite.

Nomioides maculiventris (Cameron)

In part I, p. 1, it was stated that this species visited an undetermined plant at Blaukrans. This has been determined at the Bolus Herbarium as *Galema africana* Linnaeus (Aizoaceae).

Mesotrichia seychellensis (Cockerell)

Portuguese E. Africa: Mozambique, June 6, ♂, ♀ (J. O.); Porto Ameha, June 7, ♂ (J. O.); Beira, June 4, ♀ (J. O.).

Tanganyika Territory: Tanga, ♀, June 10 (J. O.); Vidoudi and Noludu Kivungu (C. F. M. Swynnerton); Ujiji, August, ♂ (Ckll.).

S. Rhodesia: Matopo Hills, April 17-30, ♂ (Mary Fryer); Beit Bridge, April 12, ♂ (J. O., A. M.).

Transvaal: Louis Trichardt, April 4-10, ♂ (J. O.).

This species has a curious history. Vachal and other authors of his period did not distinguish it from *M. caffra*. In my account (1912) of the bees of the Seychelles Islands I described both sexes, showing that the male was quite distinct from *M. caffra*, but of the female I could only say "like that of *M. caffra* but smaller, length about 18 mm." I called it *M. incerta seychellensis*, supposing it to be a race of *M. incerta* Pérez, based on a male from Nossi-Bé, an island off the northern coast of Madagascar. Miss LeVeque (1930) described the mite *Dinogamasus cockerelli* from the pouch of *M. incerta seychellensis* from the Seychelles. She found the same species of mite in what purported to be *M. caffra* from Delagoa Bay, and this remained an anomaly because *M. caffra* at Willowmore contains a different mite, *D. braunsi* Vitzthum.

Being now in possession of much better material than before, I have gone over the whole matter, with the following results.

(1)—The female of what I regard as true *M. caffra* (Linnaeus) comes from Willowmore (Brauns), Ceres (J. O., L. O.), and Huguenot (J. O.), all in the Cape Province. The wings are rosy brown, subhyaline, not at all blue-purple. In eastern South Africa this is replaced by a form with very dark, strongly blue-purple wings, which does not differ from *seychellensis*. Undoubtedly the Delagoa Bay "*caffra*" was the same insect, and so the apparently anomalous distribution of the mites is explained.

(2)—The males recorded above agree with male *seychellensis*. Their association with the females cannot be doubted, as in the Seychelles there is only one species.

(3)—The name *seychellensis* is unfortunate, as the species belongs to E Africa, and there can now be little doubt that it was introduced into the islands with timber.

(4)—A careful analysis of the description of *M. incerta* (Pérez) shows that it cannot be this species. I have nothing exactly like it, and it presumably does not occur in continental Africa.

***Mesotrichia caloptera* (Pérez)**

Portuguese E Africa: Beira, June 4, ♂ (A. M.). This beautiful species, with splendidly violet wings, was previously known from a single example; Assinie (Alluaud).

***Mesotrichia apicalis* (Smith)**

Belgian Congo: Tshibinda, Aug. 21–27, ♀ (J. O.). Two are typical, and a third has the hair on thorax above dull tawny. The distribution of this species is remarkable; we met with it also on the south slope of Montagu Pass, in the Cape Province, near the coast.

***Mesotrichia incandescens* Cockerell**

Belgian Congo: a female from Dilolo, July 24–27 (A. M.), differs from the type in having the hair of thorax nearly all black, the red much reduced.

Mesotrichia mixta (Radoszkowski)

Transvaal: Louis Trichardt, April 4 (J. O.). A male, with short and scanty red hair on face

Mesotrichia mixta genuina (Vachal)

Tanganyika Territory: Dar es Salaam, June 9 (J. O.)

S. Rhodesia: Christmas Pass, Umtali, May 20-21 (J. O., A. M.); Matopo Hills, April 17-30 (J. O.).

Mesotrichia nigrita (Fabricius)

Tanganyika Territory: Lidodi (C. F. M. Swynnerton).

Mesotrichia mossambica (Gribodo)

The following records are of females. Enderlein wrongly wrote "*mombassica*"; the name refers to Mozambique. The clypeus has a median groove.

Belgian Congo: Elisabethville, at flowers of *Solanum*, Sept. 12 (Ckll.).

S. Rhodesia: Victoria Falls, Sept. 23 (Ckll.); Beit Bridge, April 12 (A. M.); Matopo Hills, April 17-30 (J. O., L. O.).

Mesotrichia flavescens (Vachal)

Belgian Congo: Biano, Aug. 8-11 (J. O.). The head varies in size.

Mesotrichia senior (Vachal)

FEMALES

Tanganyika Territory: Tanga, June 10 (J. O., A. M.).

Belgian Congo: Albertville, Sept. 1 (Ckll.).

S. Rhodesia: Matopo Hills, April 17-30 (J. O.); Shangani, DeBeers Ranch, May 8-12 (J. O., A. M.); Christmas Pass, Umtali, May 20-21 (J. O.).

Transvaal: Louis Trichardt, April 4-10 (J. O., G. Abendorff).

MALES

Beira (J. O.); Tanga (J. O.); and a smaller form, presumably conspecific, from the Matopo Hills (J. O.) and Louis Trichardt (A. M., G. Abendorff).

These males doubtless belong to *M. senior*, but they do not agree with Enderlein's description of the male. The following little key to males will be of service.

- 1.—Clypeus black, with a yellow mark at each lower corner; very small species, with short hair on tergites (Beira, June 4, J. O.). *cafrariae* Enderlein.
Clypeus with lower margin yellow, and at least part of a median yellow stripe (the clypeus is all black in *M. aestuans* (Linnaeus), and with a yellow border but no median stripe in *M. caffra* (Linnaeus) 2.
- 2.—Wings dark, strongly violaceous; hair of mid- and hind tarsi all black (Beira) *caloptera* Pérez.
Wings not very dark, or strongly violaceous 3.
- 3.—Hair of hind tarsi all black; of mid-tarsi black with some long pale hairs at extreme base, and short reddish hair on inner side of joints 2 to 4 (Beit Bridge) *seychellensis* Ckll.
Hind tarsi with much yellow or reddish hair 4.
- 4.—Larger; black stripe on hind tibia more than half its length (Christmas Pass, Umtali, L. O.) *somalica* Magretti. (♀ also from same place),
Smaller; black stripe on hind tibia less than half its length (Louis Trichardt). *senior* Vachal.

***Mesotrichia heterotricha* Cockerell**

Cape Province: described from Huguenot, but also occurs at Ceres, Feb. 12–18 (J. O.). Only the female is known. It is a small slender species, with black hair on head above, much like *M. scioensis* (Gribodo), but wings paler, especially basally, and hair of face mixed black and gray, the effect dusky.

***Mesotrichia divisa* (Klug)**

Transvaal: Louis Trichardt, April 4–10 (J. O.).

***Mesotrichia inconstans* (Smith)**

Males Beit Bridge, April 12 (A. M., J. O.); Louis Trichardt, April 4 (J. O.).

***Mesotrichia codinal* (Dusmat)**

Belgian Congo: Eala, Oct. 15 (H. J. Brédo).

***Mesotrichia lepeletieri* (Enderlein)**

Male. Island of San Thomé (H. de Saeger). I expected this to be an insular race or species, but can see no difference.

***Mesotrichia aestuans* (Linnaeus)**

Sudan: Khor Arbaat Delta, April–May, Ushut bush, ♂ (H. B. Johnston).

***Mesotrichia luteola* (Lepeletier)**

Belgian Congo: Dilolo, July (W. P. C.).

- 5.—Lower end of facial prominence with a shining dentiform process, directed downward; ventral scopa black. *sparganotes* Schletterer.
 Lower end of facial prominence without such a process 6.
- 6.—Ventral scopa white; end of abdomen with reddish hair *ovatus* Cameron.
 Ventral scopa not white; end of abdomen with black hair 7.
- 7.—Abdominal bands rather broad, very conspicuous, pure white; ventral scopa black, pallid basally *livingstones* Ckll.
 Abdominal bands very slender, not conspicuous except under a lens 8.
- 8.—Face very rugose, with a median keel; ventral scopa black. *atriformis* Ckll.
 Face with a very obtuse rather shining transverse prominence, and no keel; ventral scopa pale dusky reddish *subrufus* Ckll.
- 9.—Sides of tergites showing light red hair; abdominal bands broad (Morocco).
cornutus Fabricius.
 Sides of tergites showing black hair 10
- 10.—Hair of thorax above mainly black *sparganotes* Schletterer.
 Hair of thorax above not black 11.
- 11.—Larger; hair of thorax above fulvous; abdominal bands broader.
capensis Friese
 Smaller; hair of thorax above white; abdominal bands narrower *ovatus* Cameron.

The female of *L. capensis*, which I do not possess, has a yellowish ventral scopa

***Megachile marshalli* Friese**

Angola: Capelongo, July 25, 1925 (Vernay Expedition). This is distinguished from two other females with white scopa as follows

- 1.—Tegulae red (British E. Africa; Campi Simba, June 3-7, 1913, Dr. Bayer) *discolor* Smith.
 Tegulae black. 2.
- 2.—Upper part of clypeus polished and shining in middle (Katanga; Lubudi, July 27, 1923, Ch Seydel) *neweri* Vachal (*semialba* Ckll.).
 Clypeus dull, with no polished space. *marshalli* Friese.

The type locality of *M. marshalli* is Salisbury, N Rhodesia, more than a thousand miles east of Capelongo

***Megachile ekuivella* Cockerell**

Angola: Chitau, Aug. 1-12, 1925 (Vernay Expedition). Described from Angola

***Megachile admixta* Cockerell**

Angola: Capelongo, July 25, 1925 (Vernay Expedition). This is a variable and puzzling species: the present specimen (male) resembles the form found at Dilolo, Katanga.

***Heriades frontosus* Schletterer**

Belgian Congo: Stanleyville, April 30, 1915 (L. and C) The specimen is longer than usual, but the abdomen is much extended

***Heriades communis* Cockerell**

Belgian Congo: Faradje, Oct., 1912 (L. and C.)

***Heriades* (*Noteriades*) *chapini*, new species**

FEMALE—Length nearly 8 mm; slender, black, including tegulae and legs, the mandibles obscurely rufous at apex, flagellum very obscurely rufescent beneath; wings basally hyaline, apically rather strongly dusky; basal nervure falling far short of nervulus; second cubital cell long, receiving first recurrent nervure far from base (the distance equal to more than half length of first intercubitus), and second near apex; ventral scopa shining white, with a very faint golden tinge; face narrow, orbits parallel; lower margin of clypeus straight; clypeus with sharp keel running its whole length, and above to about level of antennae; sculpture of clypeus consisting of obtuse ramiform ridges, but almost lacking on each side of keel; lateral keels of supraclypeal region little diverging below, reaching clypeus about half-way between middle and lateral corners; front dull, very coarsely rugosopunctate, lateral patches of white hair, at level of supraclypeal area, very little developed, not conspicuous; mesothorax dull, with dense, very coarse punctures; hind corners of mesothorax obtusely rectangular, not produced; scutellum extremely coarsely punctured, strongly produced and sharp-edged, the margin evenly rounded, the axillae not differentiated; postscutellum shining, minutely punctured; metathorax with a deep central pit, on each side of which the surface is shining; a dense patch of white hair in front of tegulae, and a narrow band just below wings; spurs pale reddish, pale orange hair on inner side of hind tarsi; abdomen shining, well punctured; the polished basin of first tergite sharply margined; dense, pure white abdominal bands at sides only of first three tergites, and lacking on the following ones

Belgian Congo, Stanleyville, April, 1915 (L. and C.)

The species that have been referred to *Noteriades* are rather a miscellaneous lot, separable as follows

- 1.—Clypeus broadly emarginate in middle, with a large rounded tubercle on each side of the emargination (Bulawayo, S Rhodesia) *bicornutus* Friese, ♀.
Clypeus not thus emarginate 2.
- 2.—Clypeal keel not nearly reaching apex of clypeus, front coarsely and densely reticulate-punctate, robust species (Angola) *ekunensis* Ckll., ♀.
Clypeal keel running the whole length of clypeus 3.
- 3.—Apical part of mandibles with a bright ferruginous mark; tegulae dark red (Bulawayo, S Rhodesia) . . . *clypeatus* Friese, ♂.
Mandibles black, or with a little dusky red near apex, tegulae black . . . 4.
- 4.—Lateral keels of supraclypeal region strongly diverging below, going to upper corners of clypeus; posterior corners of mesothorax produced and pointed.
tricarinatus (Bingham).

Lateral keels of supraclypeal region much less diverging, reaching clypeus about half-way between middle and lateral corners; hind corners of mesothorax obtusely rectangular, not produced; narrow species, with a conspicuously narrower face *chapini* Ckll.

H. quinquecostatus Strand, which I have not seen, cannot be *H. chapini*, as the nervulus is subinterstitial; the tegulae are black, and the wings have the apical half strongly darkened, with violet iridescence. It is 8.8 mm. long.

***Tetralonia friessi* Meade-Waldo**

Belgian Congo: Kando, Katanga, March, April, 1931, twenty males (G. F. de Witte).

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A NEW HERBSTIELLA (APOIDEA) FROM NORTH AMERICA

BY CHARLES H. HICKS¹

This is the first species of the genus to be recorded from North America and the second to be described. The first species, *Herbstiella chilensis*, was named by Friese, from Chile, in 1916.

Herbstiella cockerelli, new species

FEMALE—Length about 6 mm.; anterior wing about 3.5 mm.; black, without light markings on the abdomen where the tergites have the apical margins brown, and just anterior to margins four dull yellowish spots, one pair lateral other sublateral; hair generally light gray, except mixed with black on the vertex, region of mesonotum, dense and appressed on face, rather long on cheeks and pleura, long and rather thin on scutellum; eyes black; labrum obscurely reddish; scape black; flagellum obscurely brownish beneath; vertex coarsely punctured; thorax more finely punctate; abdominal segments covered with more numerous but slightly smaller punctures with general effect dull. Mesothorax with distinct median groove; tegulae large and very bright ferruginous and minutely, sparsely punctate; wings somewhat dusky, stigma and nervures dark; marginal cell long and narrow, fully as long as first discoidal cell, second cubital cell receiving first recurrent nervure about one-fifth distance from base to end, second recurrent nervure very near apex, basal nervure meeting nervulus; legs black, with pale gray hair, the tibiae and tarsal joints with faintly yellowish hair on inner side; abdomen broad at base, segments very sparsely haired except at sides where thicker, last sternite swollen and extending slightly beyond last tergite; venter with thin hoary pubescence.

Habitat: Pasadena, California (Charles H. Hicks). Taken on May 2, 1928, flying about tunnels in old dead, live-oak stump where it gave evidence of searching for host nests.

H. cockerelli differs from *H. chilensis* by being larger, by having the second cubital cell much longer, and with recurrent nervures much more remote from each other. Another difference is that the marginal cell is less attenuated apically.

In structure the genus *Herbstiella* is between that of *Pasites* and *Blastes*. The general appearance and abdominal segments suggest *Neopasites* which, however, differs entirely in position of the first recurrent nervure and the shape of the marginal cell. It is not unlikely that when both sexes are obtained this species will have to be the type of a new genus.

¹University of Colorado

The author wishes to thank Professor Cockerell for his invaluable aid in the study of this species and to express his appreciation for similar help rendered in the past, in a study of other species.

The holotype is deposited in The American Museum of Natural History.

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DESCRIPTION OF A NEW NORTH AMERICAN SPECIES OF *LASIA* (DIPTERA, CYRTIDAE)

By J. BEQUAERT¹

Mr. C. H. Curran recently sent me a beautiful species of *Lasia*, evidently related to *L. scribas* Osten Sacken, *L. kletti* Osten Sacken and *L. yucatanensis* J. Bequaert, but amply distinct. Since I have seen all these species, I do not hesitate to describe it as new.

Lasia purpurata, new species

Large, metallic blue with strong purple reflections, moderately pilose. Punctuation very fine on thorax, coarse on abdomen. Legs black. Third antennal segment very gradually narrowed into a long, sharp apex.

MALE.—Head moderately large, flattened hemispherical. Eyes densely covered with long, grayish pile, contiguous over about the upper half of the head, between the small ocellar tubercle and the short frontal triangle. Ocellar tubercle slightly raised, narrowly triangular; the large posterior ocelli not prominent; the anterior ocellus apparently lacking, its place being taken by a minute circular pit placed close to the posterior ocelli. Antenna (Fig. 1B) narrow; first segment very short, mostly hidden within the antennal socket; second almost square in side view, with rounded upper and lower angles, about as broad as long; third about five times the length of the second, much flattened from the sides, in profile knife-shaped, with the lower margin straighter than the upper one, gradually narrowed toward the base and toward the long and sharp apex; its greatest width about the apical third. Proboscis very long and slender, longer than the body, the labium ending in two very long and narrow labella; labrum (covering the base of the proboscis in the deeply excavated face) smooth, without striation or visible punctures, with a superficial median groove. Frontal triangle very slightly raised in the middle above, without median depression. Thorax and abdomen broad and very convex, forming in profile an even curve dorsally and an almost straight line ventrally. Wing venation (Fig. 1A) similar to that of *L. yucatanensis*, but the first and second longitudinal veins united nearer

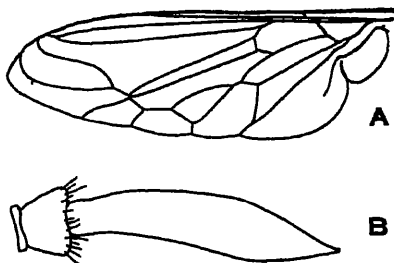


Fig. 1. *Lasia purpurata*, new species.
A, wing; B, antenna.

¹Department of Tropical Medicine, Harvard University Medical School

the costa and the upper branch of the third vein ending in the costa slightly beyond the tip of the combined first and second; the venation is much the same in both wings.

Integument of head impunctate; of thorax with very minute, rather scattered punctures, especially sparse on the mesonotum which posteriorly is almost smooth; no wrinkles on the sides of thoracic dorsum. Pleura with very fine, transverse striae. Abdomen densely punctate dorsally; the punctures coarser than in *L. kletti*, though smaller than in *L. yucatanensis*; in the center of the first and second tergites they are crowded, so that the intervening spaces are narrower than the punctures.

Body moderately hairy, much more so than in *L. scribae*, *L. kletti* and *L. yucatanensis*, but the hairs are not long and dense enough to hide or greatly dull the metallic color of the integument. Vertex and occiput with grayish pile. Dorsum of thorax densely covered with erect, moderately long, grayish white, soft hairs mixed with a few stiffer, black hairs; hairs of scutellum mostly black; pleura and sternum mostly covered with longer, black hairs. First and second abdominal tergites with many short, erect hairs, mostly black; the pilosity of the remaining tergites longer and grayish; hairs of sternites black. Legs with black hairs, rather long and dense on the femora.

Body metallic purple-blue, with very strong purplish reflections on dorsum of thorax and abdomen; under side of abdomen black, slightly purplish. Antennae: second segment black; third testaceous, blotched with black and narrowly yellow at the base. Proboscis black. Legs black; apices of femora and tarsi somewhat testaceous; claws black. Wings slightly and uniformly smoky; squamae and halteres blackish.

Length, 15 mm.; of wing, 13 mm.; of proboscis, 16 mm.

TYPE.—Latimer Co., Oklahoma; one male, holotype; June 9, 1931; V. Fisher, collector; in the American Museum of Natural History.

L. purpurata is much more densely hairy than *L. yucatanensis*, *L. kletti* and *L. scribae*, which it otherwise resembles. In this respect it approaches *L. colei* Aldrich, which, however, has a totally different sculpture, smaller antennae, yellow tarsi, etc. The rather coarse punctures of the abdominal tergites also separate it from *L. kletti* and *L. scribae*, while the exceedingly fine sculpture of the thoracic dorsum distinguishes it from *L. yucatanensis*. The shape of the third antennal segment also is characteristic for *L. purpurata*, and while the labrum of this species is smooth, that of the type of *L. kletti* bears a series of fine longitudinal ridges separated by deep grooves. This feature of *L. kletti* I forgot to mention in my earlier paper.

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SIX NEW EASTERN SOUTH AMERICAN FISHES EXAMINED IN THE AMERICAN MUSEUM OF NATURAL HISTORY

BY T. L. MARINI, J. T. NICHOLS, AND F. R. LAMONTE

Two lots of South American fresh-water fishes, one from the Museo Nacional in Buenos Aires, Argentina, the other from Dr. R. von Ihering, Instituto Biologico, São Paulo, Brazil, were recently brought to The American Museum of Natural History by Dr. Tomás Marín of Buenos Aires while he was visiting the United States on a Guggenheim Traveling Fellowship.

Several of the species in this collection appear to be new and are herein described as follows.

Pimelodus brevis, new species

Figure 1

DESCRIPTION OF TYPE.—Number 12240, American Museum of Natural History (number 1054a, Museo Nacional, Buenos Aires); from Rio de la Plata, San Fernando, Argentina; 1932; collected by Dr. Tomás Marín.

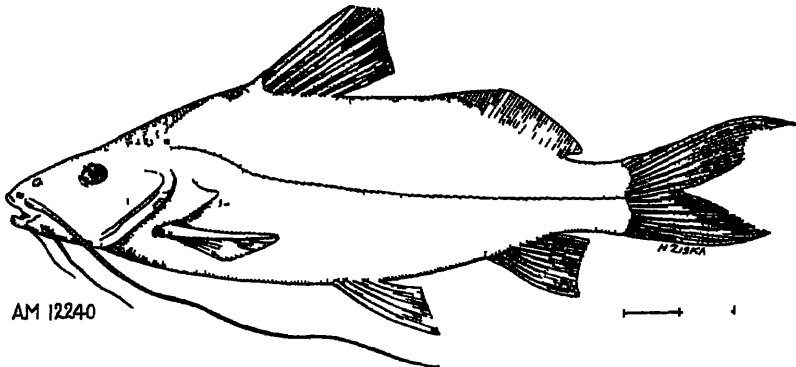


Fig. 1. *Pimelodus brevis*, new species.

Length to base of caudal, 285 mm., depth in this length, 3.5; head, 3.7. Eye in head, 6.4; snout, 2; interorbital, 3.1; width of mouth, 3; width of head, 1.4; width of body, 1.5; depth of peduncle, 2.6; its length from anal axil, 2.4; pectoral spine, 1.5; dorsal spine, 1.3; ventral, 1.5; height of anal, 2.4; upper caudal lobe the longer, 0.9; base of dorsal, 1.8; dorsal interspace the same; base of adipose, 1.3.

Dorsal, 1, 6; anal rays, 10.

Head subconical, lower jaw included for the entire width of the broad upper lip which is about one-half the diameter of the eye or more than twice as broad as lower, and about equal in width to the bands of teeth in the jaws. Interorbital appreciably convex, the fontanel extending backward to over the hind margin of the eye. Head appreciably granular forward to the middle of the eye or beyond. Occipital process strongly convex, $\frac{1}{4}$ as wide as long, in contact with dorsal plate. Humeral process triangular, pointed, its upper limb somewhat concave, extending back of the gill-opening a distance equal to $\frac{3}{4}$ of the head. The slender tip of the maxillary barbel reaches past the tip of the depressed ventral and falls short of the anal origin. Dorsal spine slender, pectoral stronger, both slightly serrate behind and the latter slightly roughened in front. Vertical height of adipose about $\frac{1}{4}$ of its base. Posterior margin of anal concave.

Specimen in its present condition is without markings, somewhat paler below than above and with fins dark gray. A slightly pale area is indicated along the upper sides differentiating a broad dark lateral shade most obvious posteriorly.

This is an unusually short-bodied species for the genus. In some respects it suggests *P. labrosus*, with which it has been compared, there being in the same collection a specimen of this 170 mm. long, from Rio Colastiné, Santa Fé, Argentina.

Pygidium alterum, new species

Figure 2

DESCRIPTION OF TYPE.—Number 12241, American Museum of Natural History (number 8549, Museo Nacional, Buenos Aires); from Rio de los Sauces, La Rioja, Argentina; 1932; collected by Dr. Marini.

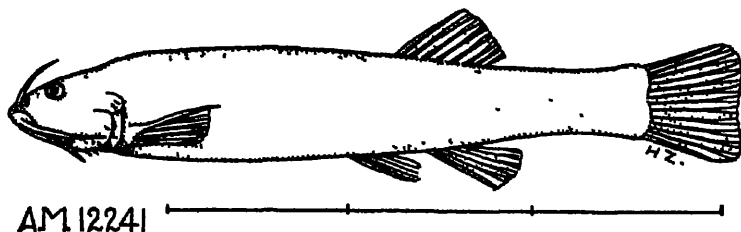


Fig. 2. *Pygidium alterum*, new species.

Length to base of caudal, 28 mm., depth in this length, 5.8; head, 5.2. Snout in head, 2.5; interorbital, 3.3; peduncle from anal axil, 3.6; nasal barbel, 2; longest maxillary barbel, 1.2; width of head, 1; depth of peduncle, 2; pectoral with filament, 1.2; ventral, 1.6; height of dorsal, 1.5; anal, 1.6; length of caudal, 1.2. Eye in snout, 2.5.

Dorsal rays, 8; anal, 7. Teeth conical, enlarged outer row.

Head depressed; body compressed. Mouth distinctly inferior; 7 or 8 spines on the opercle, about 4 on the superopercle. Gill membranes narrowly joined to the isthmus in the center. First pectoral ray a little exerted for a distance less than

diameter of the eye. Ventrals just not reaching anal; their origin equidistant from base of caudal and posterior margin of eye. Anal origin about under center of dorsal base. Caudal slightly emarginate, with rounded lobes. Color in spirits pale, unmarked.

Three other specimens are from 26–29 mm. standard length.

With these specimens was another of 37 mm. standard length, clearly representing a different species and matching the description of larger material of *Pygidium iheringi* Eigenmann sufficiently well to be at least provisionally so identified. One of the principal differences is that the peduncle from base of last anal ray to that of the middle caudal ray is contained only 4.3 times in the length to base of caudal. The head is depressed, slightly longer than broad; the peduncle strongly compressed, its length about twice its breadth. Eye in interorbital, about 2. Nasal barbel to posterior border of eye; maxillary to middle of opercle on which there are numerous spines. The upper pectoral ray is not exerted; ventrals reach about $\frac{2}{3}$ the distance to the anal, and first anal ray is situated about under last dorsal. The caudal is narrow, rounded or sub-acuminate. Head about 5 in length. Depth, 7 or 8. The specimen is too small for satisfactory examination of the teeth. Color uniform, unmarked.

Plecostomus commersonoides, new species

DESCRIPTION OF TYPE —Number 12243, American Museum of Natural History (number 1099a, Museo Nacional, Buenos Aires); from Dársena Norte, Buenos Aires, Argentina; 1932; collected by Dr. Marni.

Length to base of caudal, 318 mm; depth in this length, 4.5; head, 3.2. Eye in head, 11; snout, 1.7; interorbital, 3; width of head, 1.1; its depth, 1.7; depth of peduncle, 3.2; its length (to anal axil), 1.1; pectoral spine, 1; ventral spine, 1.2; dorsal spine, 1; longest anal ray, 3; lower caudal lobe the longer, 1; base of dorsal, 1.2; dorsal interspace, 1.9. Mandibular ramus in interorbital, 1.9. Barbel in eye, 1.

Dorsal rays, I, 7; anal, I, 4; scutes, 30; 7 between dorsal and adipose, 14 between anal and caudal. Teeth on a mandibular ramus about 40.

Pectoral reaching the first third of the ventral spine. Dorsal margin rounded, when depressed the tip of the spine reaches about to the middle of the last ray which falls short of the adipose by about the diameter of the eye. The length of the base of the fin projected backward reaches beyond the adipose. Caudal strongly, obliquely concave, corners projecting. Supraorbital ridges slightly raised. Supraoccipital with a blunt keel, but temporals unkeeled. Rows of scutes with quite evident continuous, though not strongly developed, keels. Supraoccipital bordered posteriorly by a large central and two smaller irregular plates at the sides. Lower surfaces completely scaled.

Color in preservative dark slaty gray on body and fins. Obscure dark speckles on the head and larger irregular spots on the body. Lower surface of head and breast thickly covered with more clearly defined small spots. Slight indication of spotting on the dorsal and paired fins.

A larger specimen with the same data, 402 mm. standard length, is somewhat paler colored with the spotting everywhere more noticeable, but none evident on the caudal. It has the eye 14 in the head. Interorbital, 2.7, and mandibular ramus in interorbital, 2.2 Its supraoccipital is bordered posteriorly by about four irregular scutes, and in other respects it resembles the type rather closely.

***Plecostomus niger*, new species**

DESCRIPTION OF TYPE.—Number 12245, American Museum of Natural History, our only specimen, was sent by Dr. R. von Ihering, from southeastern Brazil.

Length to base of caudal about 245 mm; depth in this length, 6; head (to margin of temporal plate), 3. Width of head in its length, 1.2; its height, 2; eye in head, 9.5; snout, 1.4; interorbital, 3; mandibular ramus, 5.8; depth of peduncle, 3; its length 1.4; pectoral spine, 1.4; ventral spine, 1.4; dorsal spine, 1.5; lower caudal lobe, 1; dorsal base, 1.6; dorsal interspace, 1.6; height of anal, 3. Length of mandibular ramus in interorbital, 1.9. Barbel in eye, 2.5.

Dorsal, 1, 7; anal, 1, 4; scutes in lateral series, 27. Teeth on mandibular ramus, about 26.

Adipose fin present, well developed. Opercle and interopercle not margined with bristles. Scutes practically keelless, except for the first three or four in the lateral series above the pectoral. Supraoccipital and temporal plates slightly raised centrally. Supraoccipital bordered by two plates or a single plate imperfectly divided in the middle. Snout somewhat more than twice as long as postorbital part of head. Orbital rim somewhat raised. Peduncle rounded below. Pectoral spine curved, enlarged and with hooked spinules at the end, reaching to middle of ventral base. Ventral reaching just past anal axil. Dorsal when depressed not nearly reaching adipose. Caudal obliquely lunate, the lower lobe much the longer. Lower surfaces well covered with small rough scales, a narrow scaleless area before the ventral bases. Tip of snout and upper lip scaleless.

Body and fins mostly blackish. Faint pale spots regularly arranged on the temporals and the front of the sides. Lower lip pale. Belly dusky with pale spots and streaks. Pectoral and ventral spines and lower caudal ray are pale. Dorsal and anal, and lower surfaces of pectoral and ventral with rather faint pale spots.

***Plecostomus meleagris*, new species**

Adipose fin present, well developed. Opercle and interopercle not margined with bristles. Length of mandibular ramus, 1.4 to 1.6 in interorbital. Some of the scutes weakly carinate. Depth of body 5 to 6 in standard length. Eye, 6.5 to 7 in head at 200–250 mm. standard length. Lateral scutes 25–28. Dorsal large, the last ray reaching almost to adipose when the fin is depressed.

DESCRIPTION OF TYPE.—Number 12246, American Museum of Natural History; from southeastern Brazil; sent by Dr. R. von Ihering.

Length to base of caudal, 240 mm; depth in this length, 5.5; head, 3.2. Eye in head, 7; snout, 1.6; interorbital, 2.8; mandibular ramus, 3.8; width of head, 1.1; its height, 2.2; depth of peduncle, 3; its length (from anal axil), 1.1; pectoral spine, 0.9; ventral spine, 1.4; dorsal spine, 1; height of anal, 2.7; lower caudal lobe, 1.1; base of dorsal, 1.4; dorsal interspace, 1.7. Barbel in eye, 1.2.

Dorsal, I, 7; anal, 4; scutes 25; teeth on mandibular ramus about 65.

Snout broad and rounded; orbital rim, center of supraoccipital and temporal plates slightly raised. Pectoral spine reaching to about the middle of ventral spine, which in turn reaches about to anal axil and the anal $\frac{1}{2}$ to caudal base. The free margin of the dorsal is somewhat rounded. When depressed, the spine reaches past the middle of the last ray which extends $\frac{1}{2}$ the distance to the adipose. Caudal obliquely lunate, the lower lobe somewhat the longer. Supraoccipital bordered posteriorly by a single scute, the one or two series of scutes along the dorsal and ventral lines weakly carinate. The lateral series anteriorly over the pectoral alone having a pronounced keel. Ventral surface of peduncle flat, not rounded, a small area at the tip of the snout and the upper lip without scales. Ventral surface mostly covered by small scales, but an area anteriorly in line with the gill openings and a broad area between and before the ventrals scaleless, except for very fine scales near the midline.

Color grayish black on back, sides, and fins, with numerous more or less pronounced pale rounded spots. These are smallest and most closely spaced on the head. Lower surfaces and ventral spines pale.

Measurements of additional specimens follow.

Measurements of Paratypes of *Plecostomus meleagris*

LENGTH STANDARD	DEPTH	HEAD	SNOUT	EYE	INTERORBITAL	MANDIBULAR RAMUS IN INTERORBITAL	SCUTES	TEETH ABOUT	BARBEL IN EYE	REMARKS
197	5.8	3.1	1.6	6.5	2.8	1.5	25	63	1.5	Last dorsal rays reach adipose
210	5.6	3.1	1.6	6.5	3	1.6	26	66	1.5	
235	5.4	3.3	1.7	7	2.9	1.5	25	60	1.2	
235	6.3	3.5	1.7	6.5	3	1.4	26	70	1.6	
245	5.1	3	1.7	7	2.8	1.6	26	67	1.7	Spots large and conspicuous on body and fins
300	5.4	3.2	1.6	8	3	1.5	28	65	2.2	Spots on body and fins small and indistinct; ventral surface rather dusky with pale spots and streaks

Plecostomus meleagris is close to *Plecostomus latirostris*, except in color. With it we have received two specimens, 160 and 220 mm. standard length, also representing an allied form, but pale with dark spots and approximately 30–40 teeth on a mandibular ramus, which we identify with *Plecostomus agna* Rabiero (1911). Mr. J. R. Norman of the British Museum (Natural History) has kindly counted teeth for us in the types of *Plecostomus latirostris* as 38 to 49, and in the type of *P. goyazensis* Regan (1907) as 28. This latter has priority over *agna*, if the two prove indistinguishable.

NOTROPOCHARAX, new genus

Mouth not protractile. Small, conical, fixed teeth present in a single series in both jaws. Caudal forked. An adipose fin present. Gill membranes free from the isthmus. Pectorals of moderate size; belly rounded. No teeth on the palate. Snout not prolonged. No antrorse, toothlike processes on the jaws. Preopercle without a spine. Scales rather large, cycloid, about 37. Lateral line incomplete. Form elongate and minnow-like; head small and mouth moderately large. Bases of dorsal and anal fins rather short.

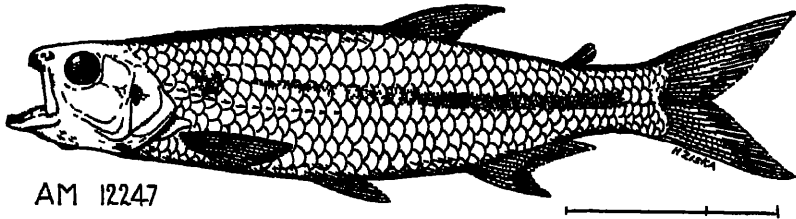


Fig 3. *Notropocharax difficilis*, new genus and new species.

Notropocharax difficilis, new species

Figure 3

DESCRIPTION OF TYPE.—Number 12247, American Museum of Natural History; from Rio Mogy-guaçu, southeastern Brazil; sent by Dr. R. von Ihering.

Length to base of caudal, 74 mm; depth in this length, 4. Head, 4.3; eye in head, 4.3; snout, 4.3; interorbital, 3.4; maxillary, 2.5; width of body, 1.9; depth of peduncle, 2.3; its length, 1.8; longest dorsal ray, 1.4; longest anal ray, 2; pectoral, 1.3; ventral, 1.9; caudal lobe, 1.

Dorsal rays, 9; anal, 15; scales, 37; gill-rakers on lower limb of first arch, about 9.

Jaws of about equal length; the lower slightly projecting. Maxillary about straight, meeting the intermaxillary at an angle, a few small teeth on its upper portion, smaller than those on intermaxillaries and mandibles. Eye placed rather high, slightly superolateral, the interorbital moderately and evenly convex. Maxillary extending to under front of pupil. Dorsal origin equidistant from base of caudal and hind margin of eye. Anal origin appreciably behind dorsal axil. Pectoral reaching a little more than

$\frac{3}{8}$ the distance to ventral; ventral more than one-half the distance to anal. Fins, including the caudal, without scales. Lateral line on 11 or 12 anterior scales only.

Color in alcohol pale, opalescent, little darker above than below, a dark blotch above the fourth scale of the lateral line, and thence a black streak extending backward that widens to $\frac{3}{8}$ the diameter of eye and becomes more conspicuous posteriorly.

There are five paratypes of about the same size (52-72 mm standard length).

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EXPERIMENTS ON THE BROODING HABITS OF THE LIZARDS *EUMECES* AND *OPHISAURUS*

BY G. K. NOBLE AND E. R. MASON

The brooding habits of *Eumeces fasciatus*, the blue-tailed skink, have been frequently described. Smith (1882), Brimley (1904), Ditmars (1904), Strecker (1908), Allard (1909), Hurter (1911), Ruthven (1911), Dunn (1920), Blanchard (1922), Brady (1927), Burt (1928), Corrington (1929), and Klots (1930) have had brooding females under their observation. Ruthven, who has given one of the most complete accounts, remarks in regard to the female and her eggs: "As is well known she remains with them until they are hatched, but for what purpose is not evident." Neither Ruthven nor the many other observers who have had brooding *Eumeces* before them have attempted experiments that might throw light on this purpose. No information is available as to the nature of the brooding response or its rôle in the economy of the species. The brooding habit is more widespread in reptiles than is usually assumed, but no one has attempted to determine whether reptiles can recognize their own eggs or even distinguish them from eggs of closely allied forms. We have studied the brooding habits of a series of *Eumeces fasciatus* and *E. laticeps* with a view to securing an answer to these questions. We have had two brooding *Ophisaurus ventralis* available for comparison and have noted various differences between the brooding of these and other reptiles.

THE EGGS OF *EUMECES*

Eumeces fasciatus has been reported to lay from 2 to 15 eggs. The smaller clutches were laid in captivity. Ditmars (1904) found that females shipped to New York deposited from 2 to 4 eggs under strips of bark. Klots (1930) describes a female as laying 2 eggs in the container where it was held captive. Strecker (1908) reports the finding in the field of several sets, each set consisting of 8 eggs, and Hurter (1911) records that a female laid 8 eggs in captivity. Corrington (1929) gives 10 to 15 as the egg-number for brooding females captured in the field in South Carolina. In western Tennessee Blanchard (1922) found a female with 9 eggs and also two females, each with a lot of 10 eggs. Ruthven

(1911) has collected several sets of eggs in Michigan and remarks in regard to the species:

"The number of eggs in the set was counted in eight instances and were as follows: 6, 6, 8, 8, 9, 11, 13, 14. An examination of the pregnant females shows that the number in each set varies with the size (age?) of the female, the smaller ones having 6 to 8 eggs, the larger ones 9 to 14."

The other records of the eggs of *E. fasciatus* fall within this range. Smith (1882) reported 9, Allard (1909) 7, Dunn (1920) 12, Burt (1928) 6, 9, 9, 9, 9, 10, and 11, and Netting (1930) 9. It is barely possible that the unusual number of 15 mentioned by Corrington may represent the laying of two females. We shall show below that if two brooding females have their nests in juxtaposition one may appropriate some of the eggs of the other.

There were only 5 eggs in the clutch described by Brimley (1904). Some of the variation in egg-number recorded above may be a consequence of abnormal conditions in captivity resulting in a reduction of the number of eggs laid, but it is also possible that the authors were considering different species. The *Eumeces fasciatus* of most authors has recently been resolved into three species (Taylor, 1932), and we have no assurance that all of the authors were describing the same form.

We have had ten females of *Eumeces* lay their eggs between damp fragments of decaying wood in the laboratory (Fig. 1). Three of these, collected in Biloxi, Mississippi, are referable to *E. laticeps*, while the others from Garnett, Anderson County, Kansas, we consider typical *E. fasciatus*. The latter average less than 10 grams in total weight, while the former group averages more than twice as much. Two of the *E. laticeps* laid 6 eggs and the other 7. Six of the *E. fasciatus* laid from 5 to 8 eggs each. This agrees well with the egg-number reported by Brimley and by Strecker. The other *E. fasciatus* deposited only 2 eggs as in the case of Klotz's captive specimen. The average number of eggs laid by our series of *E. laticeps* and *E. fasciatus* is 6 for each species. The related *Eumeces anthracinus* has been reported to lay 8 eggs (Gloyd, 1928) and *E. skiltonianus*, 5 eggs (Woodbury, 1931). The American species of *Eumeces*, so far as known, do not show any constant differences in the number of eggs laid.

Our specimens of *Eumeces* were received from Kansas and Mississippi. They laid in the laboratory earlier than the Michigan specimens described by Ruthven. He writes:



Fig 1 Brooding postures of *Eumeces*

A *Eumeces fasciatus* female digging under the eggs while encircling them with her tail B *Eumeces fasciatus* brooding female partially assuming the S-shaped posture C *Eumeces latisp* female beginning to brood her eggs

"Females taken on June 19 were pregnant, containing large eggs apparently nearly ready to be laid. The first sets observed were on July 2, and on and after this date nests of eggs were found in numbers. Everything went to show that the eggs are mostly laid about the first of July."

Our data on the egg-laying of *Eumeces* in New York may be expressed in tabular form:

LAID		HATCHED		NOTES	PER CENT HATCHED	INCUBATION TIME
DATE	NUM- BER	DATE	NUM- BER			

<i>E. fasciatus</i>							
♀ II	May 23	5	July 9	4	1 egg died	80	47 days
♀ A	May 27	8	July 5	7	1 defective jaw	87.5	39 "
♀ III	May 31	7	July 5	6	1 died hatching	85.5	35 "
♀ C	June 6	5	July 9	5		100	33 "
♀ B ₂	June 6	8	July 5	5	3 eggs died	62.5	29 "
					{ 3 shellacked		
♀ IV	June 13	6			{ 2 lost in exp.	.	
					{ 1 died		
♀ D	June 20	2	July 17	2		100	27 "
AVERAGE		6				86	35

<i>E. laticeps</i>							
♀ I	May 23	7	July 18	1	6 eggs died	14	56 days
♀ 3	May 27	6	July 5	4	2 eggs died	67	39 "
					{ 1 shellacked		
♀ E	May 28	6	July 15	4	{ 1 died hatching	80	48 "
AVERAGE		6				54	48
TOTAL AVERAGE						75	

Our eggs of *Eumeces fasciatus* measured 13 by 7 mm. when laid, and they increased in size until at the time of hatching they were from 19 to 21 mm. by 12 to 12.5 mm. Brimley (1904) records the eggs of *E. fasciatus* ready to hatch as measuring 20 by 12 mm., 20 by 15 mm., and 22 by 11 mm. Our eggs of *E. laticeps* measured from 15 to 18.5 mm. by 9 mm. when laid. They increased in size during development until they attained the size at hatching of 17 to 20 mm. by 12 mm. From these data it

is clear that the eggs of *E. laticeps* are distinctly larger than those of *E. fasciatus* at the time of laying, but before hatching the eggs of the latter species have swollen to the size of the former. We endeavored to maintain the eggs under identical conditions of moisture. Hence the more rapid increase in size of the *E. fasciatus* eggs would appear to be due to a more permeable eggshell.

Although we are not concerned in this paper with the hatching or early life of these skinks, it is of interest, in passing, to note certain differences in size between the young of the two species. It might be assumed that if the eggs were the same size the young at hatching would also be the same size. This, however, was not the case. In our series the eight young *E. fasciatus* that were measured at hatching were 23, 23,



Fig. 2. Hatching of *Eumeces fasciatus*, July 9, 1932.

24, 24, 24, 24, 25, and 25 mm long, respectively, from snout to vent. Their average length was 24 mm. The five young *E. laticeps* that were measured at hatching were 25, 25.5, 26, 27.5, and 30 mm. long from snout to vent. Their average length was 26.8 mm. At the time of hatching, the difference in head- and body-length as between *E. fasciatus* and *E. laticeps* was slightly less than 3 mm.

The hatching is accomplished by the sharp egg-tooth. This is formed of a single, elongated premaxillary tooth having its distal third bent forward nearly at a right angle to the tooth-base. The young seldom remained more than a few hours near the collapsed shells (Fig. 2), but since their nests were frequently disturbed, it is possible that they may remain together for longer periods in nature. One female in our series remained on the nest with young for over two days after they were hatched.

We supplied the young lizards with a large quantity of young larvae of the wax moth (*Galleria mellonella*) and assumed that the subsequent growth of the young skinks was normal. From our present point of view it is interesting to note that the young of *E. laticeps* grew more rapidly than did those of *E. fasciatus*. This may be considered as further evidence of distinctness of the species.

There are various differences in proportion between the young of the two species. This is expressed in tabular form on the opposite page.

Aside from the differences in proportion, there is a distinct difference in size as between the two species. The five *E. fasciatus* that were preserved within a week after hatching average 23 mm. in head- and body-length. If the young one that died in hatching be included in the series, the average is only 22.5 mm. A series of twelve young *E. fasciatus* not included in the above table averaged 24 mm. in head- and body-length when approximately a month old. The young one nearly two months old, recorded in the table, had grown to 28 mm. in head- and body-length. In contrast to these measurements, the young *E. laticeps* on hatching is approximately 3 mm. longer than is *E. fasciatus*. At one month it is approximately 4 mm. longer, and at two months, 5 mm. longer. The growth rate of *E. laticeps* is obviously greater than that of *E. fasciatus*. This probably accounts for the marked difference in size between the adults of the two species.

Taylor (1932) was aware of the fact that differences between the young of *E. fasciatus* and *E. laticeps* would probably be found on hatching. However, the youngest specimens available to him appeared to be older than he suspected. At least the measurements of our timed series would indicate that a specimen of *E. fasciatus* 26 mm. in head- and body-length was not just hatched but actually from one to two months old. Similarly we would assume a 35 mm. specimen of *E. fasciatus* was from three to four months old, and a 30 mm. specimen of *E. laticeps* was about five weeks old. It is, of course, possible that young *Eumeces* grow more rapidly in nature than in the laboratory, but we have no information on this point. Since we have given the young of both species an abundance of food, the difference in growth rate cannot be due to differential feeding.

	<i>Eumeces fasciatus</i>								<i>Eumeces laevis</i>			
	7/5 ♀ A At hatch- ing Defec- tive jaw	7/6 ♀ III Died while hatch- ing	7/7 2 days old	7/12 ♀ II 3 days old	7/11 B 6 days old	7/15 ♀ II 6 days old	8/1 23-27 days old	9/2 55-59 days old	7/18 ♀ E Died while hatch- ing	8/16 29-32 days old	9/2 46-49 days old	9/6 50-53 days old
Head to Vent	23 5	20	23	23	22	22 5	23 5	28	25	28	33	33
Axilla to Groin	11	10	11	11	11	11	12	13 5	10 5	14 5	17	10 5
Width of Head	4 5	5	5	5 25	4 75	5	5	5	5 5	5 75	6 5	7
Length of Head	6	6	6	6 5	6 5	6 5	7	7	8	8	8	9
Width of Body	4	4	4 75	4 5	4	5	4	4	5 5	5	5 5	6
Hind Leg	10	9 25	8 75	8 5	9 5	11	10 5	11 5	13	12	15	16 5
Postanal Tail												
Width	2 5	2	2 5	2 5	2 25	2 5	2 25	2 5	3	2 5	2 75	3
Hind Foot	5 5	5	5 25	5	5 5	6	6	6 5	0	7 25	7 5	8

Measurements in millimeters.

NATURE OF THE BROODING RESPONSE

Our series of gravid *Eumeces laticeps* and of *E. fasciatus* were isolated in separate cages. The bottom of each cage was strewn with damp, decaying wood, and a number of pieces of bark were laid over this. Finally a thick covering of moss was placed over the bark. Most of the females laid their eggs in the damp wood debris beneath the bark, but a few did not avail themselves of this covering.

Once the eggs were laid, most of the females remained with them, even when the bark was gently lifted. At such times the female would be found with part of her body in contact with her eggs (Fig. 1B). There appeared to be no definite position assumed by the brooding female. There were, however, three very characteristic postures. Her body was either curved in a semicircle around the periphery of the clutch of eggs, or it formed an S-shaped figure extending between them, or it was straight and lay either over or between the eggs. Although the females remained for long periods with the eggs, we were very much interested to find that they leave them voluntarily on occasions. At certain times of the day the females were found on top of the moss. These observations, frequently repeated, clearly indicate that the female normally leaves her eggs in search of warmth or food. As we shall see later, this is of great importance in aiding the incubation of the eggs.

On returning to her nest, the female invariably touched one or more of the eggs with her tongue or thrust her snout between them and partly turned over several of them. Frequently her mouth was held slightly open during this turning process, and on two occasions, we saw a female lift an egg from the ground in her mouth and gently place it in a new position. These observations were made on partly or fully exposed nests. We have no information as to how long the adjusting process continued in a fully covered nest. Whether the nest is exposed or covered, the female invariably moves the eggs and brings them together into a compact group if they are scattered. Hence we may assume that this nosing and turning of the eggs proceeds the same way in both the covered and exposed nests.

The brooding females not only returned to their nests any of their own eggs which had been scattered, but also added to their nest nearby eggs of other *Eumeces*, both *laticeps* and *fasciatus*, whether or not the eggs were of the same size. This reaction was tested eleven times. If the eggs were merely outside the nest, they were pushed in with the snout after being tested with the tongue. If the eggs were 4 or 5 cm. away, and there were more of them, they were slowly moved by the animal's

wending in and out, over and under them, moving and rolling them in the direction of the nest, as well as by pushing with the snout. Moving a number of scattered eggs into a compact group was a matter of hours, while merely returning a stray egg was in terms of minutes. We have one record of an egg's being moved back to the nest a distance of 4 cm. in less than one minute. Three eggs in a row, spaced 5 cm. apart, were rolled together in forty-six minutes. Since *E. fasciatus* reacted exactly the same toward the eggs of *E. laticeps* as it did toward the eggs of its own species, it is clear that the brooding response is not specific but may be induced by the eggs of other species of the same genus.

Ruthven (1911) noted that "there seemed to be a disposition on the part of the female to keep her set together; several times I saw a female leave her position and crawl about the eggs, and when she encountered one which I had displaced, lick it and then nose it back to the others." Our observations on exposed nests have shown that the female takes far greater care of the eggs than has been previously assumed. She not only returns stray eggs but turns over a large percentage of the eggs in the nest before settling down to brood them. Either the tongue or the snout is used to turn an egg, more frequently the latter.

Reptiles that bury their eggs naturally do not return to roll them over. Hence reptiles, as a group, differ in general from birds in that they do not turn their eggs. In fact, Halver (1931) finds that turning the eggs of *Lacerta* injures the vascular system of the embryos. This is obviously not true of *Eumeces*.

The female *Eumeces* returns at frequent intervals to her eggs. In salamanders it has been shown (Noble and Evans, 1932) that females can find their eggs even when these are placed in new localities. We were interested in testing the ability of *Eumeces* to find and identify her own eggs. Fourteen times we moved the eggs of seven females to a new locus in the cage, or to a place in a new cage in which the female had not been previously. Each time the female succeeded in finding them during the following night, if not before. We have several records of her finding them in from three to four hours. In those cases in which it was possible to observe the actions of the female, it was seen that she first returned to the old locus and investigated with her tongue and snout various objects in this place. In no case did she settle down in the old nest but invariably moved on until she found her own eggs in the new locus.

It seemed possible that we might induce *Eumeces* to brood the eggs of other genera of lizards. Both *E. fasciatus* and *E. laticeps* were tested with the eggs of *Ophosaurus* and of *Sceloporus*. As shown in the photo-

graphs, the eggs of these genera are very similar to those of *Eumeces* (Fig. 3). Nevertheless *Eumeces* responded toward them exactly as toward other foreign bodies in the nest. We performed ten experiments with the eggs of *Sceloporus undulatus* and five with those of *Ophisaurus ventralis*. In four of these, the foreign eggs were placed in the female's nest, and her own eggs put into a new locus in the cage, and once both sets were given new loci. When the nest was exposed, the females were seen to return, and feces indicated that they returned also to the covered nests. However, in no case did the female remain in her old nest with the foreign eggs. She was always found brooding her own eggs in their new locus. Twice the *Eumeces* eggs were entirely removed from the cage



Fig. 3. Eggs of *Sceloporus undulatus* (left), *Eumeces laticeps* (center), and *Ophisaurus ventralis* (right). *Eumeces* can distinguish between these three eggs and will brood only eggs of her own genus

and only the foreign eggs left. Even in the absence of available eggs of her own, she did not brood the other eggs, although the presence of feces showed that the female had investigated the nest. When her own eggs were returned to the nest, she brooded them.

Eight other tests made with the *Ophisaurus* and *Sceloporus* eggs, three with the former and five with the latter, consisted in attempting to have the *Eumeces* add these eggs to her nest along with scattered *Eumeces* eggs, which, as stated above, she invariably collected into her nest. The usual procedure of the female *Eumeces* with both the *Sceloporus* and *Ophisaurus* eggs was to investigate them with a single touch of the tongue and then to disregard them totally. Once when a rejected *Ophisaurus* egg was forced into an exposed nest, the *Eumeces* female bit the egg and broke the shell.

The question arose as to whether or not it was the odor that enabled the *Eumeces* to recognize their own eggs and reject others. Paraffin models of *Eumeces* eggs were made. These placed in a nest were never brooded by the females, nor were they added to the nest when placed near at hand. They were touched by the female with her tongue and discarded. Secondly, shellacked *Eumeces* eggs were tried. Half of the eggs of one female, three in number, were shellacked and put into her nest. The female did not brood them, although she did return to the nest and examine and move them. The three good eggs were placed 8 cm. from the shellacked eggs in the evening. The next morning, the female had collected them and was brooding all the eggs in the nest. The two groups were separated and moved to new loci. The female was not seen to brood either group and did not move them together again, although both had apparently been nosed and rolled. Shellacked eggs were tested on another female to see if she would add them to her nest. She always rejected them with one touch of her tongue whereas during the same tests she rolled normal eggs back into the nest. It is clear from these experiments that *Eumeces* will not brood artificial eggs made of paraffin nor usually her own eggs if they have been shellacked. Our one case of a female's brooding shellacked eggs may be accounted for by the fact that the female had previously rolled them about, for they had collected some dirt and possibly some of the shellac had been rubbed off.

The nostrils of two females were filled with stopcock grease and then with a combination of cotton and stopcock grease in an effort to eliminate the sense of smell from the finding and recognition of their eggs. Each time the plugs were inserted, they were removed by the animal by pressure from within and rubbing from without. Although some grease probably remained adherent, the results cannot be taken as conclusive. It may be noted, however, that the females did not return to their nests during this time.

The female *Eumeces* were blindfolded with adhesive tape which in turn was painted with "opaque" such as is used in photographic work. This tape eliminated the eyes as a means of locating and recognizing the eggs. This experiment was tried five times. Each time the female found and brooded her eggs, even when the eggs had been moved to a new locus. The record time for a blindfolded female's return to her nest, which had not been moved, was fifteen minutes. These experiments showed that the eyes were not necessary for the female to locate, recognize, and brood her eggs.

The end of the tongue above its forked tip was cut from the last female with unhatched eggs, who was a constant brooder. The tongue was cut in the morning. The female did not return to her eggs the rest of that day or on the next day. She did not seem disturbed but went about moving the tongue stump in and out in the usual manner. Previous records indicated that, even if the animal was disturbed one day, she would return to the nest by the following morning. Hence the failure to return after removal of the tongue tip appeared to us to be significant. This one record is by no means final, but taken together with the way the tongue was used by all the *Eumeces laticeps* and *E. fasciatus* in recognizing their own eggs and discarding artificial ones, it is evident that the tongue plays an important rôle in the location, identification, and turning of the eggs.

Although the tongue has this important rôle in brooding, it does not follow that the taste buds are the chief receptors of the stimulations received from the eggs. The recent work of Kahmann (1932) following upon that of Baumann (1929) has clearly shown that the primary function of the long forked tongue of snakes is to carry odorous substances to Jacobson's organ. Many lizards have tongues closely approximating those of snakes. Some species, such as *Varanus varius*, can find hidden food (Berg, 1913). Snakes have been known to swallow stones that had been used as nest eggs (Holt, 1919). Apparently the odor of the brooding bird clinging to the stones called forth the feeding responses. Since eliminating the nares of snakes does not prevent the normal prey-seeking habits while destruction of the Jacobson's organs does, it is clear that Jacobson's organ is the primary receptor of the chemical sense utilized in food-seeking. It was our intention to repeat Kahmann's experiments on the brooding *Eumeces*, but our material was not sufficient to permit more than the experiments outlined above. These experiments, although few, clearly show that discrimination is accomplished not by the eye but by the tongue. In view of this work and Kahmann's experiments with Jacobson's organ in snakes we may conclude that *Eumeces* depends chiefly on her Jacobson's organ in finding and identifying her eggs.

Many lizards extend their tongues toward apparent food before taking it into the mouth. Kahmann's snakes that had their Jacobson's organs destroyed did not take dead prey. Apparently Jacobson's organ has an important function in identifying food. It is also of apparent service to vipers that run down their prey after it has been struck by them and has run away to die from the effects of the poison (Baumann,

1929). Hence impulses coming from Jacobson's organ maintain a sustained interest in a particular object for long periods. The brooding response also represents a sustained interest. Responses to optic stimulations usually provoke attack or retreat, but in general the interest resulting from optical stimulations is less sustained. In this connection it may be noted that the elaboration of Jacobson's (=vomeronasal) organ in the Salientia is correlated with the development of a more advanced type of forebrain in the Amphibia. Herrick (1921, p. 274) remarks: "Though the differentiation of the vomeronasal organ peripherally was the initial point of departure for the fabrication of the amygdala, the complex, once developed, retains its individuality in the absence of the vomeronasal organ (alligator, man) and even of the entire olfactory system (dolphin)." Apparently Jacobson's organ has played an important rôle in building up the more advanced type of brain characteristic of the Mammalia. It is interesting to find that two habits of reptiles requiring sustained interest, namely, trail-following and egg-brooding, appear to be directly dependent on Jacobson's organ function.

We have shown that *Eumeces* would brood not only its own eggs but the eggs of any other female of its own or a closely related species. This fact is of interest, for it may form the basis of a peculiar habit which is probably widespread in the geckonid lizards. Noble and Klingel (1932) found that *Aristelligella*, which lays only a single egg, deposited this in contact with others that had been laid presumably by other females of the same species. Mell (1929) found in the vicinity of Canton 186 eggs of *Gekko japonicus* on a single window shutter of a convent which had from 60 to 80 similar shutters. Many reptiles lay their eggs together in the most suitable sites, but it is difficult to account for the colonial nesting habit of the geckos mentioned above without assuming that the gravid females are in some way attracted by the eggs of their own species. Possibly it is an incipient brooding habit manifest only at the time of egg-laying which brings them together in this distinctive way.

BROODING AS AN AID TO THE INCUBATION OF THE EGGS

The female *Eumeces* when brooding her eggs has more or less of her body in contact with them. This has induced Hurter (1911) to ask "whether the body heat of these so-called cold-blooded animals has any influence on the hatching of the eggs." Until the present no one has attempted to answer the question by determining the body temperature of a brooding *Eumeces*. We have secured the records of a series of brooding *E. fasciatus* and *E. laticeps* by determining their rectal tempera-

tures with special gas-filled, seven-inch mercury thermometers constructed by the Taylor Instrument Companies. The bulb of the thermometers measured 2 mm. in diameter and 12 mm. in length, and consequently could be inserted into the cloaca without difficulty. Each thermometer registered to 0.2°C . The same thermometers were used to take nest temperatures. The nests were dampened daily and consequently were usually lower than room temperature. The lizards were gently held in thick towels while recording their rectal temperatures. This was a very necessary procedure because the heat of the hand quickly raised the body temperature of the lizard. The thermometer remained within the cloaca until the mercury level had ceased to move. This usually required between 30 and 60 seconds. The temperature of lizards taken quietly from their nest averaged 0.4°C . higher than the temperature of the nests, in both the *Eumeces laticeps* and *Eumeces fasciatus*, with a range from 0.3°C . to 0.7°C . higher. When the females struggled or when they ran from their nests before they could be taken, their temperature was higher, ranging from 0.9°C . to 2.3°C . more than that of the nest, with an average of 1.6°C .

In cages, which were not disturbed, we repeatedly observed that the female would voluntarily abandon the nest to prowl about the cage. Especially in the late afternoon the females would leave the eggs and come out on top of the moss where they would be exposed to direct sunlight. We captured six of these females and secured their rectal temperatures with a minimum amount of disturbance to the lizards. These temperatures ranged from 1.6°C . to 3.2°C . higher than that of the nest and averaged 2.7°C . higher (Fig. 4). One temperature reading of a *Eumeces laticeps* while she was out on top of the moss was 24.1°C . as compared with the nest temperature of 20.9°C . Fifteen minutes later the female was found back on the eggs, and her temperature had dropped to 22.5°C .

These temperature readings indicate that the body temperature of the brooding female varies with the environment. When the female is out on top of the moss and bark, her temperature approaches that of the room, and when she is on the nest which is damp and under bark and has a lower temperature, the female's temperature is lower. The temperature taken fifteen minutes after return to the nest shows the rapidity with which the change is made from the higher to the lower temperature.

How often the female *Eumeces* leaves her eggs in nature is not known. On returning to the nest some of her body heat must be given to the eggs by conduction. Hence the habit of voluntarily leaving the eggs and

returning to them after a certain amount of exercise or sun-bathing results in supplying the eggs with a small but definite amount of heat.

In nature the importance of the mother's body heat in the incubation of the eggs probably varies greatly with the type of nesting site selected. In the case of eggs laid under the bark of standing stumps in river swamps

**Body Temperature of Brooding *Eumeces fasciatus*
and *Ophisaurus ventralis***

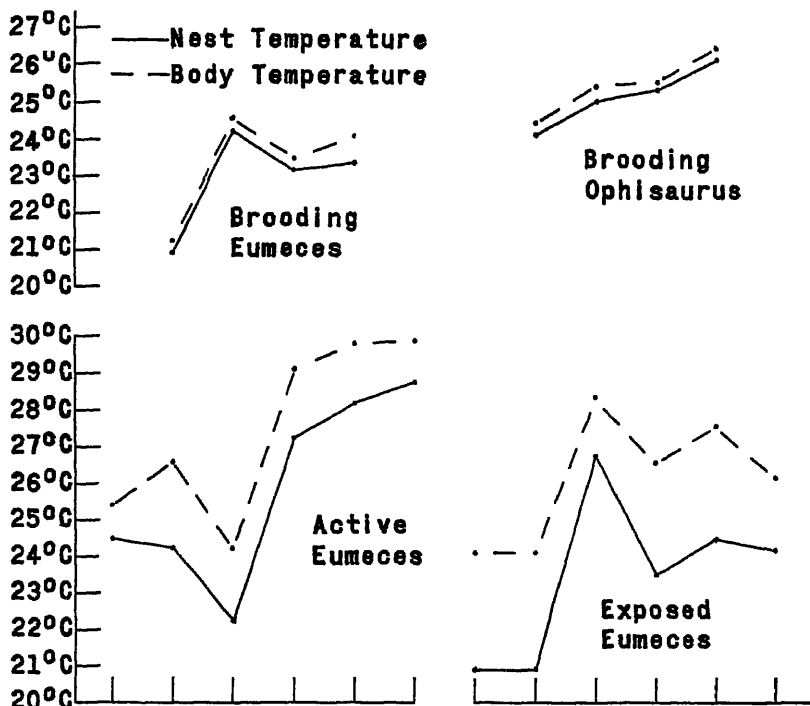


Fig. 4. Body temperature chart. The abscissa marks indicate days on which readings were taken.

such as Corrington (1929) described, or "in a hollow in a dead willow tree about fifteen feet from the ground buried in the loose, damp, rotted wood" (Blanchard, 1922), the body warmth of the female may aid the incubation considerably. On the other hand, in the case of eggs deposited under bark or wood débris exposed to the sun for long periods, it is possible that the sun aids incubation more than does the mother's

body temperature. Dr. F. W. Blanchard has informed us that in northern Michigan the *Eumeces* lay their eggs in logs exposed to the sun. Since the eggs are covered merely by the outer shell of the rotting log, their temperature is presumably greatly influenced by the sun. In such situations it is possible that the female's body temperature aids incubation chiefly at night or on dull days. Unfortunately, records of the temperature both of the logs and of *Eumeces* in the field are entirely lacking. It would be interesting to compare the time required for development of a set of eggs guarded by a female with that of another set receiving no parental care.

In nature the female lizards would have a much better opportunity to sun themselves than in the laboratory. Further, while moving over the surfaces of logs warmed in the sun, they would receive heat by conduction. We found that holding quiet *E. fasciatus* two minutes in the bare hand raised the rectal temperatures on the average, 4.6° C.; five minutes, 6.9° C.; ten minutes, 8.1° C. The rectal temperature of *E. laticeps* was also raised, but to a slightly less degree, because due to the greater size of the animal a smaller area of the body was covered by the hand.

THE BROODING HABIT A PROTECTION AGAINST ENEMIES

Although many naturalists have found *Eumeces* brooding its eggs in nature, few have commented on the possible value of this habit in the economy of the species. Klots (1930) noted that the female *E. fasciatus*, which he discovered, made no attempt to defend the eggs when he disturbed her. This is apparently the experience of other observers who fail to describe a defense reaction in the brooding female. Klots' eggs were finally eaten by another specimen of *E. fasciatus* placed in the cage with the female. It would appear that *E. fasciatus* failed to protect its eggs from the attacks of even small enemies.

We have been able to confirm Klots' observation that *E. fasciatus* does not defend its eggs against man. Our experiments with small enemies, however, are totally at variance with his views. We find that both *E. fasciatus* and *E. laticeps* vigorously protect their eggs against small enemies including mice, lizards, and snakes. Mice, both adults and young, were put into the cage with brooding *Eumeces*, and each time the female bit the mouse if it approached the nest or evinced any interest in the eggs (Fig. 5). This was tried twelve times. Once when a mouse was showing interest in some *Ophisaurus* eggs, the female *Eumeces* was about to attack the mouse, but by touching the eggs with her tongue, she dis-

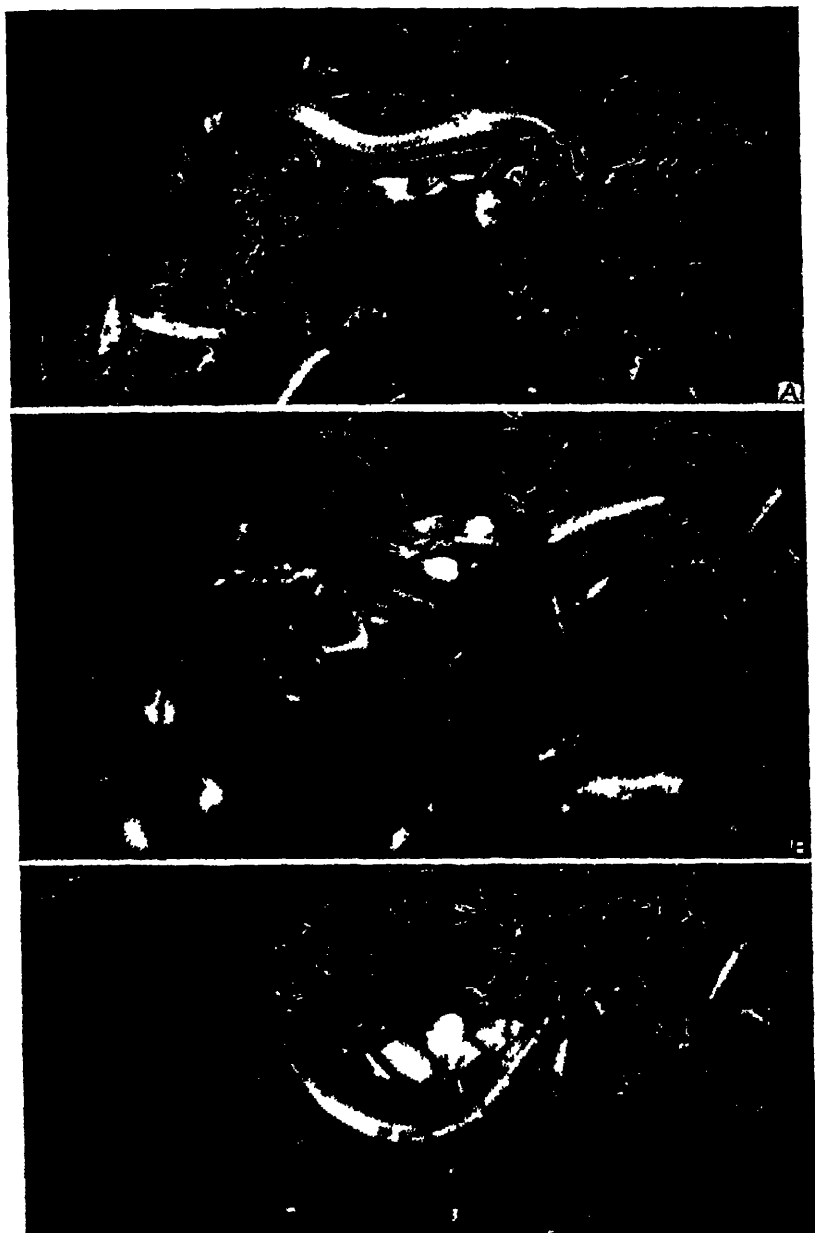


Fig 5 Brooding *Eumeces laticeps* defending her nest.

A The female while lying flat on her eggs watches an approaching mouse closely B She suddenly springs forward to bite the mouse The latter escapes (on the left) and the female thrusts out her tongue endeavoring to pick up his scent C The mouse having fled from the vicinity of the nest, the female returns to her eggs and turns them over with her snout
Photographs made during three successive trials during which the female defended her nest in essentially the same manner

covered they were not hers, and, as a result, neglected the mouse and vented her anger on the eggs, picking one up in her mouth and retreating some distance, shaking it as she went.

Lizards were tested on the brooding females. When the lizards remained quiet, showed no interest in the eggs, and did not approach the nest, the brooding female watched them, at times touched them with her tongue, occasionally chased them, but never bit them. When, however, the lizards approached the nest and eggs, she did not hesitate to bite them and so frighten them away. Other *Eumeces laticeps* and *E. fasciatus*, also *Leiocephalus inaguæ*, *Ameiva exsul*, and *Lacerta lalfordii* were used in these tests.

A gopher turtle was put into a cage with a brooding female. The *Eumeces* touched it with her tongue but did not bite it. When the turtle advanced into her nest, she retreated.

A large, striped, European snake (*Elaphe scalaris*) was tested on a brooding female, but the snake merely went into the débris and did not approach the eggs. At another time several *Thamnophis butleri* were put into a female's cage. These smaller snakes were immediately attacked by the female whenever they went in the vicinity of her nest. Larger *Thamnophis sirtalis* were tried with the same result. If the snakes were not near the nest, the female on encountering them merely touched them with her tongue, and then watched them carefully. A king snake, *Lampropeltis getulus holbrooki*, placed with a female was bitten twice without hesitation, in spite of the fact that the snake was many times larger than she. A still larger snake, a black snake, *Coluber constrictor*, was tried on the female. She ran from the snake and hid but continued to watch his movements from behind some bark and moss. She made no attempt to approach the snake, and finally when the snake started for her, it had to be removed. The king snake weighed 185.5 grams, and its total length was 84 cm. The black snake weighed 310.3 grams and measured 133 cm. Whether this 125 gram and 50 cm. difference between the snakes was the determining factor for or against an attack by the *Eumeces* female, or whether it was a matter of species cannot be concluded from these experiments. However, the black snake appeared much larger and more overpowering than the king snake, and at the time of the experiment, it seemed that size was the important factor.

Mice, lizards, and snakes were placed in cages with *E. laticeps* and *E. fasciatus* females that had not laid and with those whose eggs had all hatched. In all cases, the females disregarded all of these intruders, with the exception of the larger snakes from whom they ran when they met them face to face.

These experiments on the protection of the nests and eggs by the brooding *Eumeces* indicate that the females under normal conditions ward off enemies whether they are other lizards, snakes, or rodents. There is a size limit, but the females attack animals many times larger than themselves. These enemies are touched by the female with her tongue. If the animals do not approach the nest, they are closely watched, but if they draw near the eggs, they are immediately bitten, whereupon the intruder usually makes a rapid retreat with the female in pursuit. If given a chance within a short distance, the female frequently bites again. After the enemy has been driven away, the female returns to her nest, investigates all her eggs with her tongue, rolls them with her snout in the manner described above, and settles down again to brood them.

THE BROODING HABITS OF *OPHISAURUS VENTRALIS*

The eggs of the "glass-snake," *Ophisaurus ventralis*, have been reported by Ditmars (1904), Gloyd (1928), and Force (1930), but none of these observers have called attention to a brooding habit in this species. Apparently the brooding response is much less marked in this genus than in *Eumeces*. Pope (1929) has observed a brooding habit in the Chinese *Ophisaurus harti*. Two brooding females under his observation took flight at a slight disturbance. Since one of the nests was near a much-used foot path, this lizard had presumably left her charge only to return on many occasions. Hence we may speak of a well-defined brooding habit in this species at least.

Two of the series of *Ophisaurus ventralis* that we maintained in the laboratory during 1932 became gravid and were isolated in separate cages well provided with rotting wood and moss. One laid 15 eggs on June 2, and the other, 13 on July 13. Since both lizards came from Biloxi, Mississippi, it would seem that the breeding season in any one locality must be extensive. The first female weighed 85.1 grams and measured 235 mm. from snout to vent. She had a perfect tail 489 mm. long. The second female, the one which laid late in the season, weighed only 65.6 grams, but she measured 251 mm. from snout to vent. Her low weight was due to her short tail which had been broken and only partly regenerated and which was only 216 mm. long.

Both females brooded their eggs at intervals throughout the period of incubation (Fig. 6). Neither female was seen to bask in the sun nor even to expose much of herself to view during this time. We could secure no evidence that this species aids incubation by exercise or by sun-

bathing. On June 3 and July 18 the rectal temperature of the first female, as measured by the same thermometers utilized in the *Eumeces* work, was 24.5° C. and 25.5° C., respectively, while the nest temperature was 24.2° C. and 25.1° C. This female had apparently been lying quietly with the eggs for an extended period on both occasions, and her body temperature was only 0.3° C. and 0.4° C. higher than that of the environment.

Temperature records of the second female were comparable. On August 1 and August 9 the rectal temperature was 25.6° C. and 26.5° C.,



Fig. 6. *Ophisaurus ventralis* brooding.

respectively, while the nest temperature was 25.4° C. and 26.2° C. The female had been quiescent before the readings were taken. This may have been the reason why the body temperature of this female was also very low, only 0.2° C. and 0.3° C. higher than that of the environment. It is possible that in nature the brooding females are more active and raise their body temperatures by exercise if not by sunning. Our observations on the two brooding females in the laboratory gave no evidence in support of this assumption.

Ophisaurus was also found to differ from *Eumeces* in its failure to defend its eggs. *Ophisaurus* usually coils completely around the eggs which are laid in a single layer and are not gathered together in a pile as are python's eggs. The female may make one, one and a half, or two complete loops of her body about the eggs, but she makes no attempt to draw them together into a heap. We examined our brooding females frequently by gently lifting the cover of moss. If the female was disturbed, she quickly retreated into the mass of decayed wood or moss which covered the floor of the cage. We made frequent attempts to induce the female to defend her eggs. Mice and lizards, which immediately drew

forth an attack from the brooding *Eumeces*, caused no such response in either *Ophisaurus*

It was difficult to get the *Ophisaurus* to brood without a cover of moss. Whenever this was accomplished, tests were made. A two-thirds grown chocolate-brown mouse and a young mouse with hair present but eyes just barely open were placed in a brooding *Ophisaurus*' cage and the same reaction ensued. When either mouse approached the female, she withdrew, either partially or completely, into a temporary burrow. On another occasion, a small white mouse put into the cage crossed to the nest and sat on the eggs. The female saw it but made no attempt to chase it away. When the mouse finally walked on the head of the *Ophisaurus* female, she withdrew into a tunnel. On another day, an adult white female mouse, introduced into the cage at a distant corner, approached the eggs, touched them and retreated. This was repeated four times by the mouse. The *Ophisaurus* saw the action but made no attempt to bite the intruder. She merely cowered and pulled her head a little lower into the nest and moss. A female *Eumeces fasciatus* put into the cage, crossed to the nest, touched the eggs, walked on the female *Ophisaurus* and eggs, and finally stood with two feet on the eggs and two on *Ophisaurus* for a few moments. The *Eumeces* then continued her movements over the nest, and the female *Ophisaurus* partially uncoiled and slowly and quietly glided away underneath the moss, thus leaving the eggs unprotected. Usually the female did not move very far from the eggs, but did not return until the disturbing objects had been removed and the cover of moss replaced on her nest.

The brooding of *Ophisaurus* agrees with that of *Eumeces* in that if the eggs are moved into a new place in the cage or even to a new cage, the female will find them and begin to brood them again. *Ophisaurus* does not find her eggs as readily or as quickly as does *Eumeces*, but eventually the brooding is reestablished.

As the females did not return to the eggs when they were uncovered, we were unable to determine whether or not the eggs were touched with the tip of the tongue in making the identification. However, on four occasions, the females assembled the eggs which had been scattered among the debris on the cage floor. At such times the eggs were brought together until most of them were in contact. Since such a feat meant pushing, rolling, or carrying the eggs, it is highly probable that the snout or jaws and body were used very much as in the case of *Eumeces*.

Since the life history of *Ophisaurus ventralis* is only incompletely known, it may be of interest to report further details on the two lots of

eggs employed in this study. All of the eggs laid by the first female tapered more at one end than at the other. To our surprise none of the eggs in the second lot were as distinctly "egg-shaped" as those in the first. Many of the eggs in the second lot were incompletely calcified at one or both poles. The shell over these areas was formed of a yellowish membrane.

Of the 15 eggs that the first *Ophisaurus* laid, 3 hatched as follows: July 28, July 29, and August 1. The incubation varied from 56 to 60 days. The single one of the second lot that hatched was incubated 61 days. The first eggs were not measured when they were laid, but at hatching time they were 17 mm. by 13 mm.

The eggs of the second female were measured weekly throughout the incubation period. On July 30 the 9 eggs that had then been laid were measured. They averaged 18.2 mm. by 10.2 mm. The measurements of the individual eggs on August 1 will be given in detail to show the variation. The total 13 eggs were then available. On this date the eggs were:

16 5 by 10 5 mm.	18 by 10.5 mm.
16 5 by 11 mm.	18 by 11 mm
17 by 10 5 mm	18 by 12 mm
17 by 10 5 mm.	18 5 by 10 5 mm.
17 5 by 10.5 mm.	19 by 10 mm
17 5 by 11 mm	20 by 12 mm.
17 5 by 12 mm	

The average of these is 17.8 by 10 9 mm. The following is a table of their increase in size from week to week:

DATE	NUMBER OF EGGS	NUMBER OF DAYS OLD	AVERAGE LENGTH	AVERAGE \times WIDTH
July 30	9	0	18 2 mm.	\times 10.2 mm.
Aug. 1	13	2	17 8	\times 10 9
9	10	10	18 8	\times 13 3
15	10	16	19.3	\times 14.6
23	10	24	19 7	\times 14 8
29	10	30	20 0	\times 14 8
Sept. 6	9	38	21 1	\times 15 2
12	5	44	22 5	\times 16 5
20	4	52	23	\times 16.5
26	1	58	25	\times 19 5
29	1 egg hatched			

One egg on September 20 was 28 mm. \times 18.5 mm. It died later.

A comparison of the measurements of the eggs of the second female at laying with those of the first female at hatching shows that most of the second female's eggs were as long but NOT as broad at laying as the others were at hatching. With the continuous increase of these eggs the one that survived was at hatching much larger in both dimensions than those of the first female.

The young of the first female at hatching measured 48.5 mm., 49 mm., and 50 mm., respectively, from snout to vent and had tails 65 mm. long. The one young of the second female was 46 mm. long and had an 81 mm. tail. In spite of the great difference in the size of the eggs, the body size did not differ relatively—except the tail-length. In fact, the one from the larger egg was slightly smaller than the other three. It follows from this and from the *Eumeces* work that the size of lizard eggs at hatching may be much more variable than the size of the young lizards which hatch from them.

COMPARISON WITH OTHER REPTILES

Most lizards bury their eggs and hence would not be expected to brood them. A few species of *Lacerta*, however, have been reported to take an active interest in their eggs, carrying them in their mouths or burying them in a new place when disturbed (Hilzheimer, 1910). Many geckos lay their eggs in crannies or even in exposed situations, but as the eggs are provided with resistant shells and are frequently attached to vertical surfaces at a distance from the ground, they do not require the protection necessary for more accessible layings. The eggs of *Eumeces* and *Ophisaurus* resemble those of many snakes in being provided with membranous shells. The eggs of *Eumeces* are laid in damp rotting wood. *Eumeces* evaporates considerable quantities of water through its skin (Noble and Mason, 1932), but since the eggs are presumably in contact with a damp substratum they would probably secure an adequate supply of moisture from this source instead of from the mother's body. At present we have no evidence that the eggs of *Eumeces* require more moisture than those of such snakes as *Diadophis* (Blanchard, 1926). Nevertheless the latter are not brooded by the parent.

The brooding habit is apparently widespread in the genera *Eumeces* and *Ophisaurus*. Mell (1929) lists three Asiatic species of *Eumeces* that guard their eggs. Mell states that wherever the lizards have been found with their eggs they endeavor to prevent the removal of their charges. This behavior stands in contrast to that of *Eumeces fasciatus*

and *E. laticeps* which attacked only the smaller enemies introduced into their cages

The chief value of the brooding habit would appear to be protection from enemies. It crops up in species that provide their eggs with only superficial covering. The large South American toad, *Tupinambis nigropunctatus*, lays its eggs in termite nests and leaves them to be covered by the owners of the nest (Hagmann, 1906). The related *T. teguixin* deposits its eggs in decaying vegetation, and the mother remains to guard them (Krieg, 1925). Many snakes provide their eggs with only superficial covering, and it is perhaps not surprising to find that a variety of poisonous and harmless forms have been reported to defend them. All lizards that have been described as brooding their eggs have this in common. They depend to a large extent on their tongue in sensing the world about them. Genera, such as *Anolis* and *Sceloporus*, which depend to a greater extent upon their eyes in recognizing prey, bury their eggs or at least do not guard them. *Eumeces*, like the snakes, uses its tongue to identify objects. When deprived of vision, *Eumeces* can locate its eggs even in a foreign situation, and, as shown above, it appears to rely chiefly on the tongue to make the identification.

Since we have shown in the laboratory that the female *Eumeces* voluntarily leaves the eggs and returns to them after her body has been heated by exercise and sun bathing, the brooding habit of *Eumeces* presumably aids the incubation of the eggs. The same is very probably true of snakes. Medsger (1919) found a clutch of *Elaphe obsoleta* eggs in a cold, damp sawdust pile. Both parents sunned themselves and then returned to the eggs to incubate them. Medsger in one case found the male actually encircling the eggs and the heat of his body apparently aided their incubation. Medsger made no record of the temperature, but in a later account (1932) his description of the brooding site is very detailed and leaves no doubt that the body temperature of the brooding snake must have been markedly higher than that of the nest at the time of the snake's return to the eggs. Mell (1929) found that the temperature between the coils of a brooding *Bungarus fasciatus* was only 0.4° C. and 0.6° C. higher than that of the environment. In the case of this krait the body temperature of the female would be of little advantage to the eggs, at least at the moment her body temperature was recorded.

It is an interesting fact that in pythons, which guard their eggs continuously during the day, the brooding female is provided with a little understood mechanism for raising her body temperature. The many records of increased body temperature in brooding pythons have been

critically reviewed by Benedict (1932) who has found an increase of from 3° C. to 4° C. in the body temperature of the particular female that he and his associates studied. In other species of reptiles that have been reported to leave their eggs at intervals during the day, no such mechanism for increasing the body temperature exists. Some of the latter group such as *Eumeces* and the pilot black-snake tend to make up for this deficiency by sun bathing.

Pythons with their long daytime brooding duties may be contrasted with other brooding reptiles. Not only have they developed a high body temperature in the brooding female but they are able to lay their eggs in the open (Wall, 1911). The male has no brooding duties and does not return to the vicinity of the eggs. This is also true of some intermittent brooders such as *Eumeces* but apparently not true of several snakes. Brooding pythons seem to starve themselves more than intermittent brooders, but on this point the data is very incomplete.

Unfortunately very little is known regarding the activities of most reptiles during the brooding period. Hahn (1909) found a *Heterodon contortrix* coiled around her eggs in the soft earth of a cornfield. Female *Lampropeltis triangulum* found coiled about the eggs have been assumed to be incubating them (Babcock, 1929). Wall (1907) reports a *Ptyas mucosus* with its eggs among some bricks in a rubbish heap. Mell (1929) claims that the latter species, as well as *Ptyas korros*, *Natrix piscator*, and *N. submnata*, guard their eggs, but leave them to search for food. Mell does not, however, give the detailed evidence on which this statement is based. Pope (1929) has reported another Chinese form of *Natrix* that apparently guards its eggs. At least a female *N. percarinata* was brought to him coiled peacefully around her eggs "and beyond all doubt showed an interest in her eggs even though she would make no attempt to defend them."

It is a curious fact that some but not all of the egg-laying species of *Natrix* brood their eggs. The eggs of the common European grass snake, *N. natrix*, have been frequently found without attending parents. However, Gallwey (1932) has recently described a female as encircling her eggs and defending them for two weeks. Apparently within the genus *Natrix*, as among the varieties of domestic fowl, there may be various degrees of "broodiness"

Much more is known about the brooding habits of the cobras. Recently a pair, species not stated, bred in the zoölogical gardens in Manchester. The eggs were laid in a hollow under some sods, and both parents appeared to take turns at brooding them (Jennison, 1931). The

king cobra, *Naja hannah*, lays its eggs in a heap of leaves (Wasey, 1892; Evans, 1902; Joynson, 1917; Wall, 1924; Shaw and Shebbeare, 1931). The female apparently broods the eggs, although the male is said to remain nearby. The female *Bungarus fasciatus* has been found brooding eggs nearly ready to hatch (Evans, 1905). Since she was thin and in poor condition she presumably had not left them regularly to feed. In the case of *Naja naja* it is also the female that broods (Mell, 1929). However, Green (1905) reports that in *Bungarus ceylonicus*, "Both parents were curled up in the hollow (made like a duck's nest, but not lined in any way, just scooped and hollowed out of earth), and under them were lots of eggs and little snakes." This report, taken in conjunction with that of Jennison, would indicate that both parents brood the eggs. It would be interesting to know if the male merely returns to a favorite retreat or if he is actually attracted by the eggs in the manner of the brooding *Eumeces*. Medsger (1932) twice carried a pair of *Elaphe obsoleta* a distance of approximately a hundred yards from their nest and found that in both cases the pair had returned within a day or two. Unfortunately no other experiments have been performed with any species of snake to test the nature or strength of the attraction.

In other poisonous snakes it is apparently only the female that broods the eggs. This appears to be the case in *Trimeresurus monticola* (Leigh, 1910; Pope, 1929), *Trimeresurus rhodostoma* (Smith, 1915) and *Lachesis mutus* (Mole, 1924). It is remarkable that among the sea snakes, which as a group are viviparous, a local race or at least a group of *Laticauda colubrina* should lay eggs. Further, the female guards the eggs and snaps at intruders (Smedley, 1931). Hence the brooding habit characteristic of the cobras but lost in the viviparous sea snakes reappears in one group of these snakes that has apparently redeveloped the egg-laying habit. A similar reappearance or at least parallel development is found in the salamanders. Most species that lay their eggs on land brood them, unlike a large percentage of aquatic forms. The habit has recently been analyzed in *Desmognathus fuscus*. As in the case of *Eumeces* the females will seek out and brood the eggs of any female (Noble and Evans, 1932). Since the tongue is not protruded during the search it would appear to be the olfactory and not Jacobson's organ that aids the salamanders in making the identification. This conclusion requires experimental verification because vision was not eliminated in the experiments with salamanders.

SUMMARY

1.—The eggs of *Eumeces laticeps* are larger than those of *E. fasciatus* at the time of laying. At the time of hatching both may have swollen to the same size.

2.—The young of *E. laticeps* at hatching are larger than those of *E. fasciatus*, and they grow more rapidly during the following weeks.

3.—Both *E. fasciatus* and *E. laticeps* will brood eggs of other females, and one species will brood the eggs of the other

4.—Neither species will brood the eggs of *Sceloporus undulatus* or of *Ophisaurus ventralis*. Paraffin models of *Eumeces* eggs are rejected, and living eggs that have been shellacked are usually not attended.

5.—A blindfolded *Eumeces* will find and brood eggs even when these are placed in a foreign situation.

6.—The tip of the tongue is employed in identifying the eggs. Removing this part of the tongue prevents the female from finding the eggs.

7.—*Eumeces fasciatus* and *E. laticeps* voluntarily leave their eggs at frequent intervals to sun bathe or to seek food.

8.—Their body temperature at this time in the laboratory ranges from 1.6° C. to 3.2° C. higher than that of the eggs

9.—This increased body temperature apparently aids the incubation of the eggs when the female returns to brood.

10.—The brooding *Eumeces fasciatus* and *E. laticeps*, but not *Ophisaurus ventralis*, will attack mice, lizards and snakes of moderate size that approach their eggs.

11.—The female *Ophisaurus ventralis* can find her eggs when these are placed in a foreign situation, but under laboratory conditions she does not increase their temperature in the manner of *Eumeces*.

12.—The eggs of *O. ventralis* may vary greatly in their increase in size during development, and yet the young on hatching from these eggs may be nearly the same size

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A STUDY OF THE GREEN PIT-VIPERS OF SOUTHEASTERN ASIA AND MALAYSIA, COMMONLY IDENTIFIED AS *TRIMERESURUS GRAMINEUS* (SHAW), WITH DESCRIPTION OF A NEW SPECIES FROM PENINSULAR INDIA¹

BY CLIFFORD H. POPE AND SARAH H. POPE

This paper is based primarily upon the large number of pit-vipers in the collection of the British Museum (Natural History) and that of The American Museum of Natural History. Its object is to show that no less than five species are commonly identified as *Trimeresurus gramineus* and also to prove that these five species not only are distinct structurally but geographically or ecologically as well.

It has long been known that certain green species of *Trimeresurus* are not readily separated from one another, and a study of the literature makes it evident that all but one of the forms treated here have been more or less understood by previous workers, but it is equally evident that their relationships have never been worked out or set forth by any one herpetologist. The species described as new below has been consistently confused with *gramineus* even though it is not even closely allied to that or any other species dealt with herein.

A study of the hemipenis of nearly every valid species of *Trimeresurus* has convinced us that this genus may be divided into groups of allied forms having different types of hemipenes. A simple key will suffice to show that the six species described in this paper possess no less than three distinct types of structure in this organ. The distribution of each species is given.

¹Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 115.

- A.—Hemipenis relatively short and thick, with numerous, well-developed spines.
- 1.—Spines present only just distal to point of forking where they extend across the entire width of organ except that part occupied by sulcus. (Upper Burma eastward across southern China and Tongking to Formosa and Hainan). *T. stejnegeri*.
 - 2.—Spines distributed from just distal to point of forking nearly as far as tip of organ but always separated from sulcus by a calyculate area. (Peninsular India). *T. occidentalis*, n. sp.
- B.—Hemipenis long and slender, entirely devoid of spines.
- (Upper Burma and southern China southward into the Malay Archipelago to Timor). *T. albolabris*.
- (Upper Burma southward into the Malay Archipelago). *T. gramineus*.
- (Southern Burma and the Malay Peninsula to the Isthmus of Kra). *T. erythrurus*.
- (Malay Peninsula south of the Isthmus of Kra) *T. purpureomaculatus*.

The hemipenis at best is a difficult character because it is useless when females and very young examples are in question. It is, therefore, deemed wise to give a key based upon more usual characters even though such a key fails to show true relationships so well and must depend in part upon geographical data.

- A.—Scales smooth or with barest trace of keel on some mid-dorsal rows. *T. occidentalis*, n. sp.
- B.—Scales keeled.
- 1.—First upper labial entirely separated from nasal by a suture.
Distributed from Upper Burma eastward across southern China and Tongking to Formosa and Hainan. *T. stejnegeri*.
Distributed from Upper Burma southward into the Malay Archipelago. *T. gramineus*.
 - 2.—First upper labial entirely or partly united to nasal.
 - a.—Dorsal head scales granular; temporals and scales adjacent to posterior upper labials distinctly keeled.
 - aa.—Color uniform dark brown to blackish, or green with dark blotches above; usually 19 or more rows of scales just before vent *T. purpureomaculatus*.
 - bb.—Uniform light green above and below; usually 17 or less scale rows just before vent *T. erythrurus*.
 - b.—Dorsal head scales not granular; temporals smooth or weakly keeled; scales between temporals and posterior upper labials smooth. *T. albolabris*.

As recently as 1927, Stejneger attempted to settle the question of the relationship and distribution of the Chinese species of the pit-vipers considered here but he was not successful because he did not realize that more than two forms were involved. In fact, nothing short of a close comparison of types with large series of the various species would have permitted anyone to solve a part or the whole of this difficult problem.

We have tried to present data that will enable others to separate the various species involved and, while doing so, check our conclusions. Further study of the literature is costly in time and of little value because the diagnostic characters are rarely given. We have noticed many minor differences that will, we believe, when studied more fully, serve as good subspecific characters. This applies chiefly to the more widespread forms. The question of subspecific division is left entirely to the future and not even discussed here.

Before giving detailed descriptions we wish to emphasize what has already been indicated: i.e., the extreme difficulty of the problem involved. When we first discovered the striking differences between the hemipenes of *stejnegeri* and *gramineus*, in spite of a marked similarity in external form, Dr. Malcolm Smith suggested that perhaps the hemipenis itself is very variable. In order to check this point, we examined and tabulated data on the hemipenes of large numbers of males from widely separated localities and found the amount of variation to be very little.

One question of general interest is raised by the present study: i.e., is the hemipenis more or less stable than the various external scale characters generally relied upon for the determination of species and even genera? Also, is it more valuable for the separation of large or small groups in the classification of snakes? In the genus *Trimeresurus*, the hemipenis is excellent for the separation of the various species into groups, but we think it would be dangerous to generalize until more detailed data on this organ in other genera are available.

The descriptions have been written to serve as a model for future descriptions of all species of *Trimeresurus*, not merely to enable one to distinguish the forms treated herein.

We wish to thank Mr. H. W. Parker of the British Museum for the generous way in which he put the material under his care at our disposal.

Trimeresurus occidentalis, new species

Lachesis gramineus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 554 (part).

TYPE.—British Museum Register No 82.8.26.40; ♂, not fully mature; Mudmalley, Wynad, southwestern India; Beddome, collector

DESCRIPTION OF TYPE.—Rostral three times as broad at base as at tip and much broader at base than high. Internasals broad, only slightly elongate, separated by a scale half the size of each internasal, a little larger than largest adjacent head scales. Nasals not constricted in middle, undivided, not concave, completely separated from first upper labial on one side, two-thirds separated on other. Second upper labial

high, forming anterior border of pit. Upper part of second upper labial separated from nasal by two small scales and some bare skin on one side, one very small scale and bare skin on other. Two scales of nearly equal length on a line between eye and nasal, anterior one forming upper angle of canthus rostralis. Supraoculars a little longer than horizontal diameter of eye, as broad as average anterior head scale and extending backward a little farther than posterior margin of orbit. Inner margins of supraoculars unbroken by sutures and separated by eight to nine head scales. Internasals separated from supraoculars by two scales, neither of which differs markedly in size or shape from other anterior head scales. Upper head scales smooth, irregular, medium in size posteriorly, noticeably increasing in size anterior to eyes. The center of line connecting anterior extremities of supraoculars is separated from scale between internasals by two scales. Two postoculars on each side; suboculars separated from upper labials by one scale on each side. Temporal scales smooth, not noticeably enlarged. Pupil vertical. Eye separated from labial border by distance equal to its horizontal diameter and from tip of snout by a distance two and one-half times this diameter. Upper labials 9-9. Lower labials 10-10, first pair in contact behind symphyseal. Chin shields regular, first pair slightly enlarged. Scales generally smooth but with bare trace of obtuse keel sometimes discernible. Anteriorly, mid-dorsal scales are long, narrow, convex and not imbricate; while posteriorly they are slightly longer, three times as broad, flat and slightly imbricate. Scale rows 21-19-17-15; reduction by loss of 5th row occurring approximately opposite 60th, 50th, and 29-34th ventral plates, respectively, counting forward from anal; first count taken one head-length behind head. Ventrals 154. Anal entire. Caudals 60, divided. Snout to vent 230 mm. Tail 99 mm.

Hemipenis moderate in length, extending to 8-9th caudal plate, forked opposite the 3d plate. Sulcus bordered on either side by a broad calyculate area extending to tip of organ. Numerous spines present from a point just distal to forking to or nearly to tip. Many spines well developed, the largest with free end $1\frac{1}{2}$ mm. in length.

Color uniform green above; yellowish white beneath, the latter color extending on to the first row of scales anteriorly, and on to the upper lip to the horizontal level of the lower margin of the eye.

There are five paratypes in the British Museum as follows:

- 2♂; Matheran, east of Bombay City; ventrals 174 and 175, caudals 71 and 70+
♂; Bramaghernes, southwestern Peninsular India; ventrals 145; caudals 55
♀; "Cuddapa Hills," eastern Peninsular India, about 14° N. lat.; ventrals 177;
caudals 59
♀; Shevaroya, eastern Peninsular India, about 12° N. lat.; ventrals 171;
caudals 58

The scale formula is uniformly 21-19-17-15. The supraoculars are entire except that in one specimen each is nearly divided into two by a suture. The internasals are always well separated by two or three scales or else one large scale partly divided, while the first upper labial is completely cut off from the nasal on both sides. Small scales are uniformly present between the nasal and the part of the second upper labial forming the anterior border of the pit.

DISCUSSION.—This new form may be compared to *anamallensis* and *strigatus* from Peninsular India as follows: in *T. strigatus* the second

upper labial is distinct from the scale forming the anterior border of the pit, while in *occidentalis* these scales are united; moreover, *strigatus* has a complicated blotched pattern in browns, while the new form is uniform green above with a trace of pattern evident in the young. In *T. anamallensis*, an ally of the new form, the supraoculars are nearly always divided, the scales, including those of the temporal region, distinctly keeled, and the dorsum with varying amounts of black pigment, especially evident on the tail where it takes the form of complete rings. In contrast to this, *T. occidentalis* rarely (if ever) has divided supraoculars. Its scales are never keeled in the temporal region and only slightly so along the middle of the back, while, as already stated, it is almost devoid of pattern.

T. occidentalis has long been confused with *gramineus* auct. which proves, however, to include at least four species, some of them not even closely allied to one another as shown by their distinctive types of hemipenes. The form here described may be separated from all others long included with it under *gramineus* not only by its characteristic hemipenis but by its geographical isolation as well.

It is significant to note that Wall¹ (pp. 49-50) writes of "*T. gramineus*" as follows: "It is found in the Eastern Ghats, Western Ghats, Nilgiris and other hills in the Peninsula of India. It does not occur in the plains of India, but affects an altitude of from 1500 to 6000 feet. East of Calcutta it occurs in the plains and hills alike." Here we have good evidence that *occidentalis* exhibits a definite habitat preference and that no plateau or plain form of *gramineus*, such as *albolabris*, is found in Peninsular India. Wall's "it," following the phrase, "East of Calcutta," obviously does not refer to *occidentalis*.

Trimeresurus stejnegeri Schmidt

Trimeresurus stejnegeri SCHMIDT, 1925, Amer. Mus. Novitates, No. 157, p. 4 (type locality, Shaowu, Fukien, China).

Trimeresurus yunnanensis SCHMIDT, *loc. cit* (type locality, Tengyueh, Yunnan, China).

Trimeresurus gramineus stejnegeri STEJNEGER, 1927, Proc. U. S. Nat. Mus., LXXII, Art. 19, p. 9.

Trimeresurus gramineus stejnegeri POPE, 1929, Bull. Amer. Mus. Nat. Hist., LVIII, p. 478.

The type may be described in more detail as follows:

ADULT MALE—A. M. N. H. No. 21054; Shaowu, N. W. Fukien, China; Andrews and Heller, collectors.

¹WALL, F. 1928 "The Poisonous Terrestrial Snakes of our British Indian Dominions (including Ceylon) and How to Recognise them, with Symptoms of Snake Poisoning and Treatment." Bombay

Rostral two and one-half times as broad at base as at tip and much broader at base than high. Internasals indistinct, not or barely elongate; separated by four scales about size of internasals. Nasal not constricted in middle, not divided, not concave, completely separated from first upper labial on both sides; second upper labial high, forming anterior border of pit. Upper part of second upper labial separated from nasal by one medium-sized scale on one side, in contact with nasal on other. Two scales on a line between eye and nasal, posterior one a little deeper and longer; anterior one forming upper edge of canthus rostralis, which is distinctly projecting. Supraoculars narrow, with slightly irregular inner margins and separated from one another by twelve head scales; one supraocular divided anteriorly. Internasals separated from supraoculars by four scales on each side, no one of which differs markedly in size or shape from other anterior head scales. Upper head scales medium and fairly regular in size, not noticeably enlarged anteriorly; smooth. The center of line connecting anterior extremities of supraoculars is separated from scale between internasals by four to five scales. Postoculars 2-3; suboculars separated from upper labials by two scales on each side. Temporal scales not or only slightly enlarged, smooth. Pupil subelliptical. Eye separated from labial border by a distance equal to its horizontal diameter and from tip of snout by two and a half times this diameter. Upper labials 10-11. Lower labials 13-12, first pair in contact behind symphysal. Chin shields irregular, first pair enlarged. Anteriorly, mid-dorsal scales are about half as broad as they are posteriorly. With the exception of outer row on each side, scales are distinctly but obtusely keeled throughout, the keel traversing entire length of scale except on neck. Scale rows 21-19-17-15; reduction by loss of fifth¹ row occurring approximately opposite 63d, 53d¹ and 45th ventral plates, respectively, counted forward from anal; first count taken one head-length behind head. Ventrals 165. Anal entire. Caudals 62, divided. Snout to vent 577 mm. Tail 111 mm.

Color uniform green above, somewhat lighter green below. A narrow, yellowish lateral stripe along the middle of the first scale row; this stripe stops on neck anteriorly and a little beyond vent posteriorly. Tip of tail pale reddish. Head without pattern or postocular stripe.

The hemipenis of A. M. N. H. No. 33225 from Chungan Hsien, northwestern Fukien, is short and thick, extending to 13-14th caudal plate, forked opposite 7-8th; spinous basally, calyculate distally. Twelve to thirteen large spines, first five very large, nearly equal in size and extending across entire width of organ; rest of spines gradually decreasing in size; numerous minute spines proximal to large spines. Lips of sulcus devoid of spines and not prominent. Calyces without scalloped edges.

The following specimens in the British Museum were examined:

- ♂; Kuatun, Fukien, China; ventrals 168; caudals 69; scales 21-21-14²
- ♂; Near Ningpo, China; ventrals 169; caudals 70; scales 23-21-15
- 5♂; Formosa; ventrals 162, 162, 155, 158, 162; caudals 70, 68, 69, 67, 69; scales 21-21-15 for all five
- ♂; Mogok, Upper Burma; ventrals 159; caudals 65; scales 21-19-15
- ♂; Himalayas; ventrals 155; caudals 64; scales 21-19-15
- ♂; Sikkim Himalayas; ventrals 157; caudals 58 (+?); scales 21-19-14 (13)
- ♂; Shillong, Khasi Hills, Assam; ventrals 158; caudals 64; scales 21-21-15

¹The preservation of the type renders a determination of the point at which the second reduction occurs most difficult. It is also hard to see which row is involved.

²Counted a head-length behind head, at midbody, and just before vent.

Trimeresurus gramineus (Shaw)

Coluber gramineus SHAW, 1802, 'Gen. Zool,' III, part 2, p. 420 (type locality, Vizagapatam, India; based on Russell's 'Ind. Serp.' I, Pl. ix)

Trimeresurus gramineus GUENTHER, 1864, 'Reptiles Brit. India,' p. 385, figs. (part).

Lachesis gramineus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.' III, p. 554 (part)

A typical specimen of *gramineus* may be described in detail as follows:

ADULT MALE—British Museum Register No. 72.4 17 137; Khasi Hills, Assam; Jerdon, collector.

Rostral nearly three times as broad at base as at tip and much broader at base than high. Internasals distinct, elongate; separated by a scale one-half size of each internasal. Nasal not constricted in middle, not divided, not concave, completely separated from first upper labial on both sides; second upper labial high, forming anterior border of pit. Upper part of second upper labial separated from nasal by two large scales on either side. Two scales on a line between eye and nasal, posterior one a little deeper and longer; anterior one forming upper edge of canthus rostralis which is distinctly projecting. Supraoculars narrow, with irregular inner margins; broken up posteriorly into small scales and separated from one another by thirteen to fourteen head scales. Internasals separated from supraoculars by four scales on each side, no one of which differs markedly in size or shape from other anterior head scales. Upper head scales medium and fairly regular in size, not noticeably enlarged anteriorly; keeled posteriorly and in temporal regions. The center of line connecting anterior extremities of supraoculars is separated from scale between internasals by four to five scales. Suboculars separated from upper labials by two scales on each side. Temporal scales not noticeably enlarged. Pupil vertical. Eye separated from labial border by a distance equal to its horizontal diameter and from tip of snout by a little more than twice this diameter. Upper labials 9-10. Lower labials 12-12; first pair in contact behind symphyseal. Chin shields regular, first pair enlarged. Anteriorly, mid-dorsal scales are about one-third as broad as they are posteriorly. With the exception of outer row on either side, scales are distinctly but obtusely keeled throughout, keel traversing entire length of scale except on sides of neck. Scale rows 23-21-19-17-15; reduction by loss of 5th row occurring approximately opposite 142d, 58th, 50th and 38th ventral plates, respectively, counting forward from anal; first count taken one head-length behind head. Ventrals 165. Anal entire. Caudals 70, divided. Snout to vent 758 mm. Tail 167 mm.

Hemipenis long and slender, extending to 25-26th caudal plate, torqued opposite 7-8th plate. Entirely devoid of spines. Calyculate from tip of organ nearly to point of forking. Proximal to this, longitudinally folded. Sulcus prominent throughout.

Color uniform green above; lighter green below. First row of scales on each side brown with yellow tip, second row yellow below keel. The narrow bichromate lateral stripe thus formed ending just behind head anteriorly and at vent posteriorly, incompletely developed on tail. Tip of tail pale reddish. Head without pattern or postocular stripe.

The following specimens were examined in the British Museum:

- ♂; Darjeeling, Bengal; ventrals 166, caudals 56+; scales 21-21-15
 ♂; Mergu, Tenasserim; ventrals 161; caudals 71; scales 21-21-15
 ♀, 3 ♂; Prov Wellesley, Malay Peninsula; ventrals 164, 163, 161, 168; caudals 58, 74, 75, 72; scales uniformly 23-21-15
 ♀, ♂; Pinang, Malay Peninsula; ventrals 165, 163; caudals 61, 75; scales 23-19-15, 21-21-15
 ♂; "Sungei, Kumbang, Korinchi," Sumatra, 4700 ft.; ventrals 146; caudals 64; scales 21-19-15
 ♀, ♂; "Lao Mts., Cochun-China"; ventrals 168, 164; caudals 62, 73; scales 21-21-15, 23-21-17
 ♂; Saap, Kina Balu, Borneo; ventrals 155; caudals 74; scales 21-21-15

***Trimeresurus erythrurus* (Cantor)**

Trigonocephalus erythrurus CANTOR, 1839, Proc. Zool Soc. London, p. 31 (type locality, Ganges Delta)

Trimeresurus erythrurus GUENTHER, 1864, 'Reptiles Brit. India,' p. 386 (part).

Lachesis gramineus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 554 (part).

The type may be described in more detail as follows:

IMMATURE MALE.—British Museum Register No. 94.6.25.15; Ganges Delta; Cantor, collector.

Rostral one and one-half times as broad at base as at tip and much broader than high. Internasals broad, only slightly elongate, broadly in contact, much larger than adjacent head scales. Nasal not constricted in middle, not divided, not concave; save for very short suture (on both sides) in posterior margin, united with first upper labial. Second upper labial high, forming anterior border of pit. Upper part of second upper labial slightly separated from nasal by a minute scale on either side. Two scales on a line between eye and nasal, anterior one a little shorter, forming slightly projecting upper angle of canthus rostralis. Supraoculars a little longer than horizontal diameter of eye; twice as broad as average mesial head scales and extending backward about as far as posterior margin of orbit. Inner margins of supraoculars unbroken by sutures and separated by thirteen to fifteen head scales. Internasals separated from supraoculars by four scales; first twice as big as average anterior head scales, others agreeing with these in size and shape. Upper head scales granular, moderately irregular, small in size. The center of line connecting anterior extremities of supraoculars is separated from internasals by five scales. Two postoculars on each side; suboculars separated from upper labials by one scale on each side. Temporal scales distinctly but bluntly keeled, somewhat enlarged. Pupil vertical. Eye separated from labial border by distance equal to its vertical diameter and from tip of snout by a distance slightly greater than twice this diameter. Upper labials 9-10. Lower labials 12-12, first pair in contact behind symphysial. Chin shields regular; first two pairs enlarged. Mid-dorsal scales scarcely twice as wide posteriorly as anteriorly. With the exception of outer row, scales are distinctly but obtusely keeled throughout, keel traversing entire length of scale except on sides of neck. Scale formula¹ irregular but

¹The bad condition of the type makes an exact determination impossible.

approximately 21-23-21-19-17-15, the reduction from 21 to 15 taking place on the posterior half of the body. Ventrals 174. Analenture. Caudals 67, divided. Snout to vent 395 mm. Tail 73 mm.

Color uniform green above; lighter green below. Scales of first row with yellow center, the resulting stripe extending from just behind head to vent, beyond which it shifts to tips of subcaudals and soon disappears. Tip of tail greenish brown, incompletely banded with dark brown. Upper lip lighter than top of head; no postocular stripe.

The type is a female and the hemipenis of the largest male is immature. The organ, however, is long and slender, devoid of spines and has a prominent sulcus. No further details can be ascertained but it may safely be concluded that the hemipenis is of the same general type as that found in *albolabris*, *gramineus*, and *purpureo-maculatus*.

The scale formula of the type being irregular and difficult to determine, that of the specimen from Pegu is given here. Complete formula 25-23-21-19-17. From a point a head-length behind the head to approximately opposite the 60th ventral plate, counted forward from the vent, the scales are in twenty-five rows. From this point reductions follow in rapid succession until a minimum number of 17 is reached near the 20th plate.

The following specimens in the British Museum were examined:

- ♀, ♂; Burma; ventrals 161, 104; caudals 44+, 79; scales 23-23-15, 23-23-16
- ♀; Toungoo, Lower Burma; ventrals 162, caudals 52; scales 25-25-17
- ♀; Pegu, Lower Burma; ventrals 161; caudals 56; scales 25-25-17
- 2 ♀, ♂; Rangoon, Lower Burma, ventrals 171, 165, 163; caudals, 58, 59, 66; scales 25-23-17, 25 (26)-25-17 (18), 23-23-17
- ♀; Moulmein, Lower Burma; ventrals 158; caudals 55; scales 21-21-15

Trimeresurus albolabris Gray

Trimeresurus albolabris GRAY, 1842, 'Zool. Misc.', p. 48 (type locality, China).

Lachesis gramineus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.', III, p. 554 (part).

One of the types may be described in more detail as follows:

HALF-GROWN FEMALE—British Museum Register No 122.a; China; Reeves, collector

Rostral twice as broad at base as at tip, a little broader than high. Internasals broad, elongate, broadly in contact, much larger than adjacent head scales. Nasal not constricted in middle, undivided, not concave, each nasal half separated from its first upper labial by two sutures. Second upper labial high, forming anterior border of pit. Upper part of second upper labial in contact with nasal on both sides. Two scales on a line between eye and nasal, the anterior much the shorter and forming upper angle of canthus rostralis. Supraoculars much longer than horizontal diameter of eye, as broad as largest anterior head scales, and extending backward as far as posterior margin of orbit. Inner margins of supraoculars scarcely broken by sutures, separated by ten to twelve scales. Internasals separated from supraoculars by three scales on one side, four on other, no one of which differs markedly in size or shape from other anterior head scales. Upper head scales smooth, irregular, scarcely increasing

in size anteriorly. Center of line connecting anterior extremities of supraoculars is separated from internasals by four scales. Two postoculars on each side. Suboculars separated from upper labials by one scale on each side. Temporal scales smooth, scarcely enlarged. Pupil vertical. Eye separated from labial border by distance equal to nearly twice its vertical diameter and from tip of snout by three times this diameter. Upper labials 10-11. Lower labials 12-13, first pair in contact behind symphysial. Chin shields regular, first pair somewhat enlarged. All but first two or three outer rows of scales obtusely keeled.¹ Anteriorly, mid-dorsal scales about half as wide as posteriorly. Scale rows 21-19-17-15, the reduction from 21 to 19 taking place somewhere posterior to 70th ventral plate counting forward from anal. Ventrals 152. Anal entire. Caudals 49, divided. Snout to vent approximately 435 mm. Tail 75 mm.

Color uniform green above; yellowish white below. Each scale of first row with light center, the resulting stripe extending from neck, where it is somewhat widened, to vent. On tail, it is present laterally on subcaudals, but soon disappears. The yellowish white color of belly is present on upper lip to horizontal level of lower margin of eye. No postocular stripe. Tip of tail pale reddish.

The hemipenis of the other type is very long and slender, entirely devoid of spines, extending to 21st caudal plate, forked opposite 5-6th plate. Finely calyculate from tip of organ nearly to point of forking. Lips of sulcus prominent throughout.

The following specimens were examined in the British Museum:

(Type) ♂; China; ventrals 156; caudals 62; scales 23-21-15

♀, ♂; Hongkong; ventrals 163, 159; caudals 53, 69; scales 21-21-15, 23-21-15

2♂; Formosa; ventrals 154, 149; caudals 65, 62; scales 21-21-15, 23-21-15

♂; Darjeeling, Bengal; ventrals 164; caudals 64; scales 21-21-15

♀; Dibrugarh, Assam; ventrals 168; caudals 56; scales 23-21-15

♀; Mogok, Upper Burma; ventrals 161; caudals 53; scales 23-21-17

♂; Tounggyi, S. Shan States, Burma; ventrals 165; caudals 65; scales 21-21-15

♀; Moulmein, Lower Burma; ventrals 167; caudals 55; scales 21-21-15

2♀; Siam; ventrals 164, 158; caudals 57, 40(+?); scales 20-21-15, 21-21-15

♂; Kontum, Annam; ventrals 166; caudals 72; scales 21-21-15

♂; Sumatra; ventrals 162; caudals 73; scales 21-21-15

3♀, 3♂; Java; ventrals 159, 165, 170, 161, 165, 164; caudals 60, 54, 62, 73, 71, 75; scales 23-21-15, 21-21-15, 21-21-15, 21-21-15, 21-21-15, 21-21-14

♀, ♂; Lombok; ventrals 162, 166; caudals 57, 74+; scales 21-21-15, 21-21-15

♂; Sumba; ventrals 160; caudals 72; scales 20-21-15

♀; Flores; ventrals 164; caudals 57; scales 21-21-15

♂; Ombaya, Allor; ventrals 163; caudals 71; scales 21-21-15

♀; Timor; ventrals 164; caudals 58; scales 21-21-15

2♀; Kupang, Timor; ventrals 165, 166; caudals 56, 57; scales 21-21-15, 21-21-15

¹The bad condition of this snake posteriorly makes the determination of this character as well as the exact scale formula extremely difficult

Trimeresurus purpureomaculatus (Gray)

Trigonocephalus purpureomaculatus GRAY, 1834, 'Ill. Ind. Zool.,' I, Pl. LXXXI (type locality, Singapore).

Lachesis purpureomaculatus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 553 (part).

The type may be described in more detail as follows:

ADULT FEMALE.—British Museum Register No. 1.2 4.a; Singapore; Hardwicke, collector.

Rostral a little less than twice as broad at base as at tip, much broader than high. Internasals reduced, scarcely twice as large as adjacent head scales, barely elongate; separated by two scales, each about size of internasals. Nasal not constricted in middle, undivided, not concave, almost completely united with first upper labial, there being no dividing suture in front and only the trace of one behind. Second upper labial high, forming anterior border of pit. Upper part of second upper labial separated from nasal by one small scale on either side. Three scales on a line from eye to nasal, first largest, second smallest; anterior one forming upper edge of canthus rostralis which is scarcely concave. One supraocular as long as vertical diameter of eye, the other extended forward and longer than this diameter; as broad as average anterior head scales; extending backward about to posterior margin of orbit. Inner margins of supraoculars unbroken by sutures and separated by sixteen head scales. Internasals separated from supraoculars by six scales on one side and eight on the other, none of which differs markedly in size or shape from adjacent head scales. Upper head scales small, granular, uniform in size. The center of line connecting anterior extremities of supraoculars is separated from scales between internasals by eight scales. Three postoculars on one side, one on the other; suboculars separated from upper labials by three rows of scales on either side. Head scales, including temporals and those adjacent to upper labials, bluntly but distinctly keeled. Pupil vertical. Eye separated from labial border by twice its vertical diameter and from tip of snout by nearly three times its horizontal diameter. Upper labials 11–11. Lower labials 15–15, first pair in contact behind symphyseal. Chin shields regular, first pair greatly enlarged. Mid-dorsal scales twice as broad posteriorly as anteriorly. With the exception of outer row, scales are distinctly but obtusely keeled throughout, keel traversing entire length of scale except on sides of neck. Scales in twenty-seven rows, one head-length behind head, in nineteen just before vent, abnormal along most of body.¹ Ventrals 163. Anal entire. Caudals 59, divided. Snout to vent 818 mm. Tail 147 mm.

Color uniform dark brown above and lighter brown beneath; lower part of first row of scales same color as belly, forming a faint lateral stripe which is set off from the belly by the darkened tips of the ventral plates.

The type being a female, the following description of the hemipenis is based on a male from the type locality. Hemipenis very long and slender, entirely devoid of spines, extending to 20th subcaudal plate; forked opposite 3d plate; finely calyculate from tip of organ nearly to point of forking. Laps of sulcus very prominent throughout and calyculate.

The squamation of another example from the type locality is described here because, as already stated, the type is abnormal. From a point one and one-half head-

¹See page 12 for scale formula of a normal individual.

lengths posterior to head, the complete formula is 27-29-27-25-23-21-19. The increase from 27 to 29 takes place approximately opposite 114th ventral plate counted forward from vent, and 29 rows are maintained until opposite 66th plate. Posterior to this, reductions follow one another in rapid succession and the minimum count of 19 is reached about opposite 18th plate from vent.

The following specimens in the British Museum were examined:

- ♀, 2 ♂; Singapore; ventrals 165, 163, 163; caudals 64, 77, 76; scales 27-29-19, 27-25-19, 28-25-19
- Juv. ♀, juv. ♂; Straits of Johore, southern Malay Peninsula; ventrals 166, 167; caudals 60, 73; scales 27(about)-27-19, 27-26-19
- 2 ♀; Pinang, Malay Peninsula; ventrals 165, 170; caudals 57, 63; scales 27-27-19 in both
- ♀; Puket, Peninsular Siam; ventrals 170; caudals 69; scales 27-26-20
- ♀; Yumeekee, Mergui, Tenasserim; ventrals 171; caudals 58+; scales 26-25-17
- ♂; Dinding Ida., Malay Peninsula; ventrals 168; caudals 60+; scales 27-27-19
- ♂; "India"; ventrals 161; caudals 74; scales 27-25-19

CONCLUSIONS

1.—The snakes commonly identified as *Trimeresurus gramineus* represent several species, some of them not even closely allied. Two of them, *T. stejnegeri* and *T. albolabris*, have been clearly recognized as distinct forms by Mell, Stejneger, Schmidt, C. H. Pope, and others, while one, *T. occidentalis*, is described here as new, having never before been recognized in print as a valid form. It is not even closely allied to any of the species treated in this paper.

2.—In defining the species and groups of species of *Trimeresurus*, the hemipenis is of great importance.

3.—After the hemipenis, the scutellation of the head is most important, while that of the body is of little significance. In the species considered in this paper, the following scale characters are most diagnostic:

- a).—Shape and size of internasals and presence or absence of scales between them.
- b).—Relation of first upper labial to nasal.
- c).—Presence or absence of scales between the upper part of the second upper labial and the nasal.

In the past, sufficient weight has never been placed upon these primary characters.

4.—Female *T. gramineus* and *T. stejnegeri* cannot be distinguished from each other with certainty, while mature males are recognized at once by the form of the hemipenis. Immature males generally may be separated by color characters. The meaning of this external similarity in two forms with radically different hemipenes is not understood but may be correlated with ecological adaptations. Therefore, field studies are much needed.

5.—The value of the hemipenis in the classification of snakes calls for further investigation as it is by no means clearly understood.

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THE SKULL AND MANDIBLE OF *CONOHYUS*, A PRIMITIVE SUID FROM THE SIWALIK BEDS OF INDIA

By EDWIN H. COLBERT

INTRODUCTION

Conohyus, a genus proposed by Pilgrim in 1926,¹ is a suid of mid-Tertiary age, found in the Lower Siwalik beds of northern India. It is closely related to *Hyotherium*, the typical Miocene pig of Europe, from which genus it differs by certain aberrant specializations which will be described below.

Hitherto our knowledge of *Conohyus* and *Hyotherium* has been based on dentitions and fragmentary skulls, and consequently it has been rather incomplete. A skull and a mandible of *Conohyus*, of which a detailed account will be given in this paper, as well as various dentitions—all collected by Mr. Barnum Brown in the Northern Punjab of India during the field season of 1922—add greatly to our knowledge as to the cranial anatomy of the Miocene Suidae.

The illustrations in this paper were made by Margaret Matthew.

THE SKULL.—The skull and mandible here described have been identified as *Conohyus sindiense* (Lydekker).

The skull, Amer. Mus. 19616, which was collected at a point stratigraphically 1600 feet above the level of Chinji Rest House, Punjab, and linearly one and one-half miles north of that location, was badly crushed and broken when found. The several fragments constituting it have been assembled to the best of our ability, and all in all they go to make up a reasonably complete specimen. This skull is of medium size, representing an animal somewhat comparable to the Babirusa pig in its proportions. It is, generally speaking, long and slender, and as might be expected of a Miocene suid, is distinguished by the small size of its brain case.

When viewed from the side, the skull is seen to have an essentially straight cranial profile, with but a slight dip or "stop" just above the orbit, a character typically suiline in its expression. The muzzle would seem to be relatively slender, much as in *Palaeochoerus*,² with a slight preorbital depression immediately anterior to the orbit. The infraorbital foramen has its anterior opening above the anterior border of the

¹Pilgrim, G. E. 1926. 'The Fossil Suidae of India.' Mem. Geol. Surv. Ind., Pal. Ind., N.S., Vol. 8, No. 4, p. 12.

²For comparisons with *Palaeochoerus*, reference is made to the figures by Filhol, M. H. 1890. 'Mammifères fossiles de Saint Gerand le Puy,' Bib. de l'Ecole des Hautes Etudes, Sec. des Sci. Nat., Tome 20, Art. 1, plates 4-10.

Also see Pearson, H. S. 1927 'On the Skulls of Some Early Tertiary Suidae, etc,' Phil. Trans. Roy. Soc. Lond., Ser. B, Vol. 215, p. 392. (Comment on Filhol's figures.)

third premolar, a position similar to that in *Palaeochoerus*, and one especially typical of the more primitive Suidae. That *Conohyus* is a specialized form is especially well illustrated by the heavy development of the zygomatic arch. In *Palaeochoerus* the arch is of normal size, relatively comparable to the arch in a female *Sus*, originating above the third molar and being of fairly uniform height along the extent of its length, while in *Conohyus*, the zygomatic process of the maxilla has become greatly expanded, so that the lower border of the arch extends down below the occlusal line. In conjunction with this expansion of the arch is its strong connection with the ascending portion of the maxilla. The zygomatic process, instead of arising from an antero-posteriorly short pedicle, is joined to the side of the face by a lengthened junction, extending from above the mid-portion of the third molar to a point above the third premolar. This connection of the arch with the vertical portion of the maxilla takes the form of a ridge, merging above into the preorbital depression, and below into the lower border of the arch, and terminating abruptly in front as a knob-like protuberance. Since the arch is extended downwardly, there is a long narrow pocket or furrow beneath this connection with the maxilla, which must have furnished room for a strong buccinator muscle. The lower border of the zygomatic arch reaches its lowest extension opposite the pterygoids, and from thence rises rapidly to the level of the glenoid.

The orbit is relatively small, as in other pigs, and is but partially closed behind by the postorbital processes of the maxilla and of the frontal. There is a small lacrymal bursa in the usual place, on the front border of the orbit.

The brain case, being small, becomes very narrow opposite the post-glenoid border, and this has necessitated the development of large sagittal and lambdoidal crests for the attachments of the temporal muscles. Such a character is typical of many primitive mammals, and in *Conohyus* is a direct inheritance from *Palaeochoerus*. The supraoccipital and the adjacent bones extend far back and overhang the condyles. The glenoids are fairly well raised above the occlusal line, being placed about as in the modern *Sus*. It might be well to say, in passing, that this normal position of the glenoids is the factor causing the expanded zygomatic arch to extend below the occlusal line. In *Phacochoerus*, for instance, the arch is deeply expanded, but due to the height of the glenoid the lower border of the arch is raised to quite a distance above the occlusal line.

At this point we may consider briefly the question of preorbital and postorbital lengths. As was shown by Osborn¹ and Gregory, the primitive perissodactyls are characterized by the close equality between the length of the face in front of the anterior border of the orbit, and the length of the cranium behind that same point. From such primitive forms, various lines of evolution followed separate trends, in some of which, such as the horses, the face increased greatly in length, while in others, like the titanotheres, it became extremely short. Turning now to the Suidae, we see that the primitive members of the family are marked by the approximate equality of preorbital and postorbital lengths, while among the advanced forms the tendency is for the face to become in-

¹Osborn, H. F. 1929. 'The Titanotheres of Ancient Wyoming, Dakota and Nebraska.' U. S. Geol. Surv., Monograph 55, Pt. 2, pp. 820-834. (With the cooperation of W. K. Gregory.)

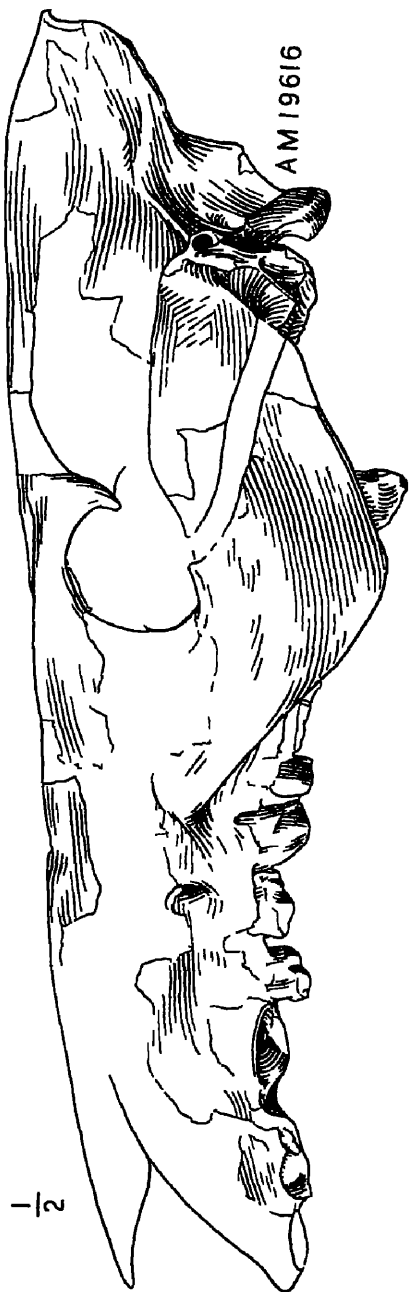


Fig 1.—*Conohyus sandwicense* (Lydekker). Amer. Mus No 19616. Side view of skull, one-half natural size. The specimen has been crushed, so that its true height would be somewhat greater than shown in the figure. (See Fig. 5 for restoration.) Restored portions unshaded.

creasingly long. Thus, in the skull of *Palaeochoerus* (as measured from Filhol's figure) the preorbital length is to the postorbital length as 110 is to 100, a fact that argues strongly in favor of the consideration that *Palaeochoerus* is close to the ancestor of all of the Suidae. *Conohyus* shows a slight advance in the increase of facial length as compared to cranial length, the ratio here being about 133 to 100. In the later suids the increase becomes greatly accentuated, reaching a ratio of 220 to 100 in the modern *Sus*. *Phacochoerus*, a relatively recent offshoot from the *Sus* line, is extremely specialized in that the face is four and a half times as long as the postorbital length.

These figures are inserted to show that *Conohyus* is but little advanced beyond the primitive *Palaeochoerus* type as to the ratio between facial and postorbital lengths. Thus it becomes apparent that most of the specializations of the suid skull which are closely associated with the lengthening of the face, have occurred in post-Miocene time.

The striking feature of the skull, as seen from the top, is the constricted brain case, which in *Conohyus* seems to show little if any advance in relative size over the brain case of *Palaeochoerus*. As a corollary to the unexpanded cranium, the zygomatic arches at their posterior limits stand out prominently from the skull, and from their posterior borders the occiput extends far back, being constricted at its proximal boundary, and flaring somewhat at the lambdoidal crest.

The palate is largely destroyed, being preserved only along the lingual edges of the cheek teeth. Suffice it to say that the posterior narial opening is just behind a line joining the posterior edges of the talons of the third molars. The pterygoids would seem to be moderately heavy, as would be necessary for the attachment of strong pterygoid muscles.

The basicranium is only partially preserved, but enough remains to give us a glimpse of certain of the anatomical features. As was pointed out above, the malars project widely at their posterior borders. This is an attribute of the wide glenoids, which indicate a mandibular attachment of considerable strength. In shape, the glenoids are like those of *Palaeochoerus*, with low borders along their sides, and with but slightly elevated postglenoid borders. The feeble development of the postglenoid border is a suid character, correlated with a rather free movement of the lower jaw during mastication. The bulla shows a precocious development towards the form typical of recent suids. It is very long and narrow (due to crushing the true width cannot be exactly determined) and it projects down to a distance almost equal to its

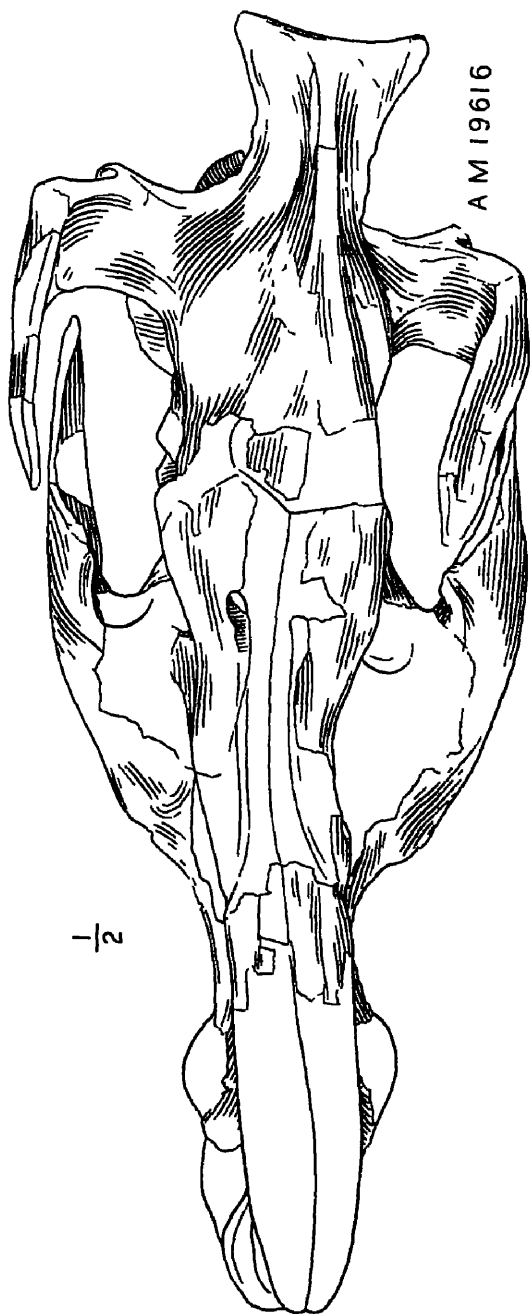


Fig. 2.—*Conohyus sindiense* (Lydekker). Amer. Mus. No. 19616. Top view of skull, one-half natural size

length. This is a shape intermediate between the primitive bulla, which would be small and more or less globular, and that of the modern suids, in which the bulla is considerably deeper than it is long. The posterior half of the inner side of the bulla is joined to the basioccipital, and from this latter element a peculiar protuberance projects down on the inner side of the bulla. This connection between the bulla and the basioccipital causes the foramen lacerum medius to be quite separate from the foramen lacerum posterius. As in the modern suids, the foramen lacerum medius is confluent with the foramen ovale. The external auditory meatus is enclosed within a long tube, which runs along the back side of the glenoid, and its opening is directed backward and upward.

The paroccipital process is closely appressed to the posterior edge of the bulla, and naturally the stylomastoid foramen occupies a position intermediate between these structures. Only the proximal ends of the paroccipital processes are preserved, but it is presumed that they are relatively long, as is usual among the Suidae. Filhol has shown moderately long paroccipitals on *Palaeochoerus*, and naturally in connection with rather strong pterygoids, serving for the attachment of heavy internal pterygoid muscles, it would be expected that in the genus under discussion the paroccipitals would be well developed, in order to afford attachments for strong digastric muscles. Thus *Conohyus* shows its typically suilline affinities in the apparent strength of its masticatory muscles.

THE MANDIBLE.—The mandible, Amer. Mus. 19739, comes from the lower portion of the middle Siwalik beds, at a location four and one-half miles west of Hasnot, northern Punjab. Although coming from an horizon somewhat above that of the skull, the jaw is nevertheless of the same species, and so nearly identical are the lower molars, as compared to the corresponding teeth in the skull, that the two specimens, for the sake of comparative study, may be considered together. The mandible is relatively heavy, with a deep ramus, and with a broad ascending ramus and a fairly wide condyle. The symphysis is very strong and short, and it indicates a wide spread of the rami at the condyles. The anterior opening of the mental foramen is situated below the anterior border of the second premolar.

DENTITION.—The teeth of *Conohyus sindiense* have been described by Lydekker¹ and Pilgrim,² so it seems unnecessary to go into great detail on this subject. The specimens in the American Museum collection do, however, give a few additional points which were not seen in the original and more fragmentary material.

As has been demonstrated by Pilgrim, 1926, the genus *Conohyus* is distinguished by the enlargement of its second and third premolars,

¹Lydekker, R. 1894 'Siwalik and Narbada Bunodont Suids.' *Pal Indica*. X, Vol. 3, Pt. 2, p. 95, plate 13, figs. 5-10.

²Pilgrim, G. E. 1926 'The Fossil Suidae of India.' *Mem Geol Surv Ind.*, *Pal Indica* N S, Vol. 8, No. 4, p. 12, Plate 2, figs. 1-6.

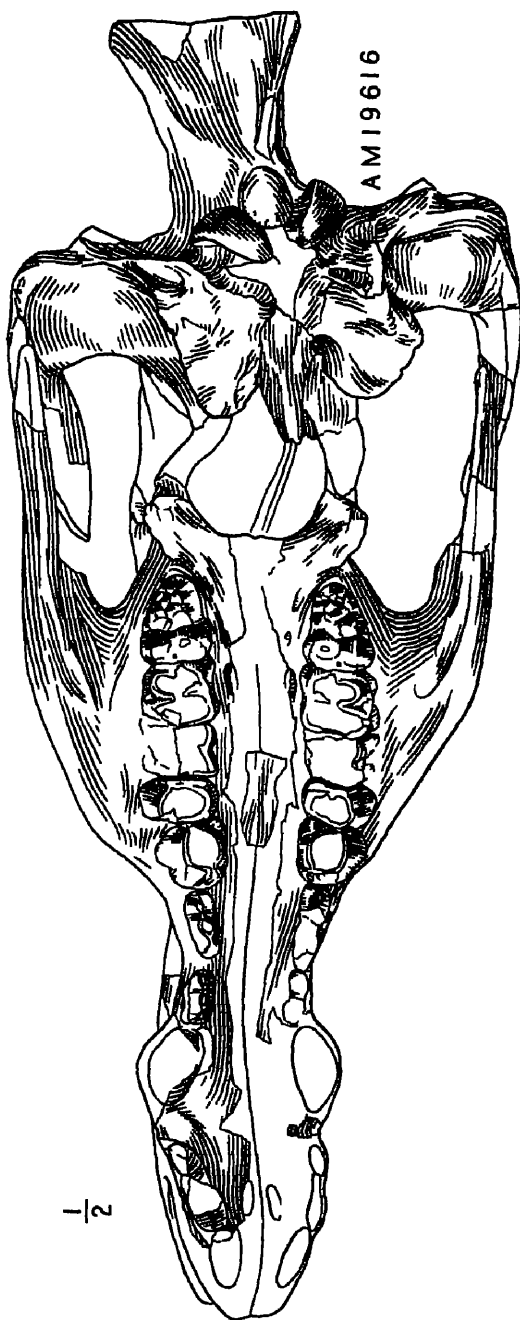


Fig. 3.—*Conohyus sindiense* (Lydekker) Amer. Mus. No. 19616. Palatal view of skull, one-half natural size.

this being a specialized character setting the Indian form apart from the typical European Miocene *Hyotherium*. The material at hand bears out the validity of Pilgrim's interpretation. In the upper dentition the teeth are all set closely together, there being but a slight diastema between the first and second premolars and another very short gap in front of the canine. The canine turns strongly outward. In both upper and lower jaws the incisors are crowded and immediately precede the canines, showing that there was no lengthening of the snout as in later pigs.

The first and second premolars above and below are very narrow teeth, each consisting of a central cusp, with a ridge running anteriorly and another posteriorly from it. The teeth posterior to the second premolars are as Pilgrim described them. His description may be summed up as follows. The third upper premolar consists of a large cone with a well developed but low cusp on the postero-internal corner of the tooth, and an anterior cusp. The fourth premolar is considerably wider than it is long, and when worn the outer and inner portions of the tooth become confluent. In the lower jaw the third and fourth premolars are single cones, the latter with an elevated posterior ridge. The first and second upper molars are four-cusped, with slight anterior and posterior cingula, while the third molar has in addition to the four cusps, a short talon, separated from the body of the tooth by a single median cusp. The first two lower molars are quadricuspid, and the last molar has, in addition to the talonid, two median conules.

TABLE OF MEASUREMENTS

SKULL

Length, occ cond. to tip of premaxilla (approximate)	277 mm.
Width, at glenoids	123
Preorbital length	164
Postorbital length (to condyles)	123
Ratio Preorbital : Postorbital :: 133 : 100	
Vertical diameter of orbit	37
Width across occ. condyles	40
Over all length (back of occiput-premaxilla)	317

MANDIBLE

Length, condyle to anterior border of first premolar	182 mm.
Depth of ramus below first molar	45
Height of condyle above occlusal line	54

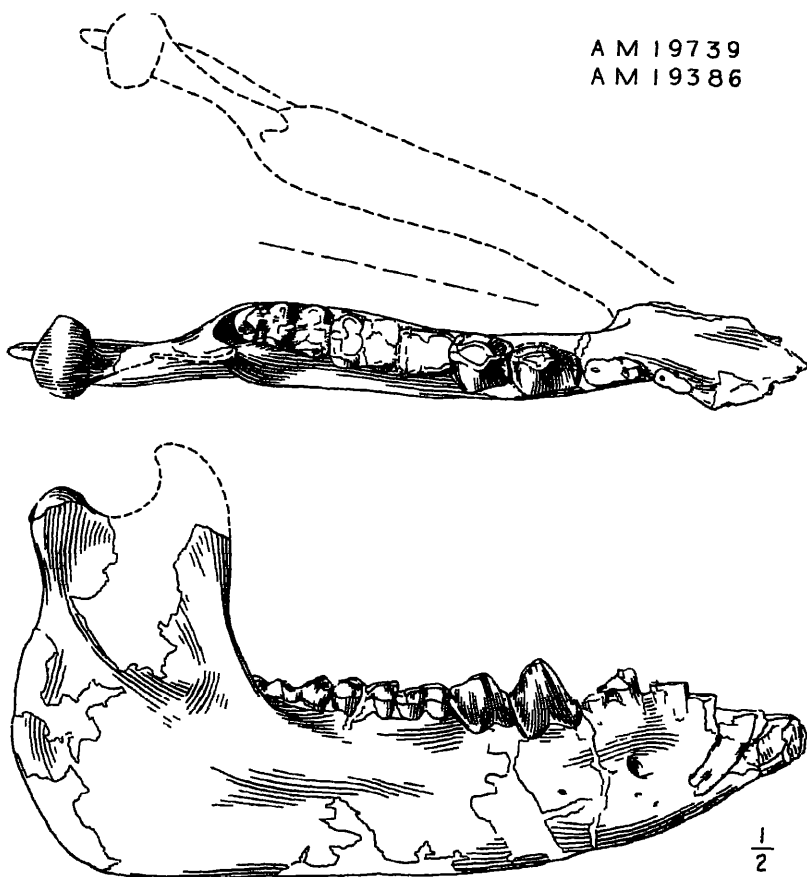


Fig. 4.—*Conohyus sindiense* (Lydekker). Amer. Mus. No. 19739. Mandible, with the third and fourth premolars and the first molar drawn in from Amer. Mus. No. 19386. Crown view above, and side view below. One-half natural size.

UPPER DENTITION, Amer. Mus. 19616

	Anteroposterior	Transverse
I ² estimated from alveolus	10 mm.	5 mm.
I ³ " " "	7	4
C " " "	17	13
P ¹	13	6
P ²	17	7
P ³	16	16.3
P ⁴	11.5	17.5
M ¹	12.8	16.5
M ²	18	18
M ³	20	17
Premolar length	60 mm.	
Molar length	52	
Ratio	115 : 100	

LOWER DENTITION, Amer. Mus. 19739

	Anteroposterior	Transverse
C	15 mm.	7.5 mm.
P ₁	11	4
P ₂	17	7.5
P ₃ (From A. M. 19386)	18	14
P ₄ " "	16	15
M ₁ " "	14	11.7
M ₂	18	15
M ₃	26	14.7
Length of premolar series	65 mm.	
Length of molar series	58	
Ratio	112 : 100	

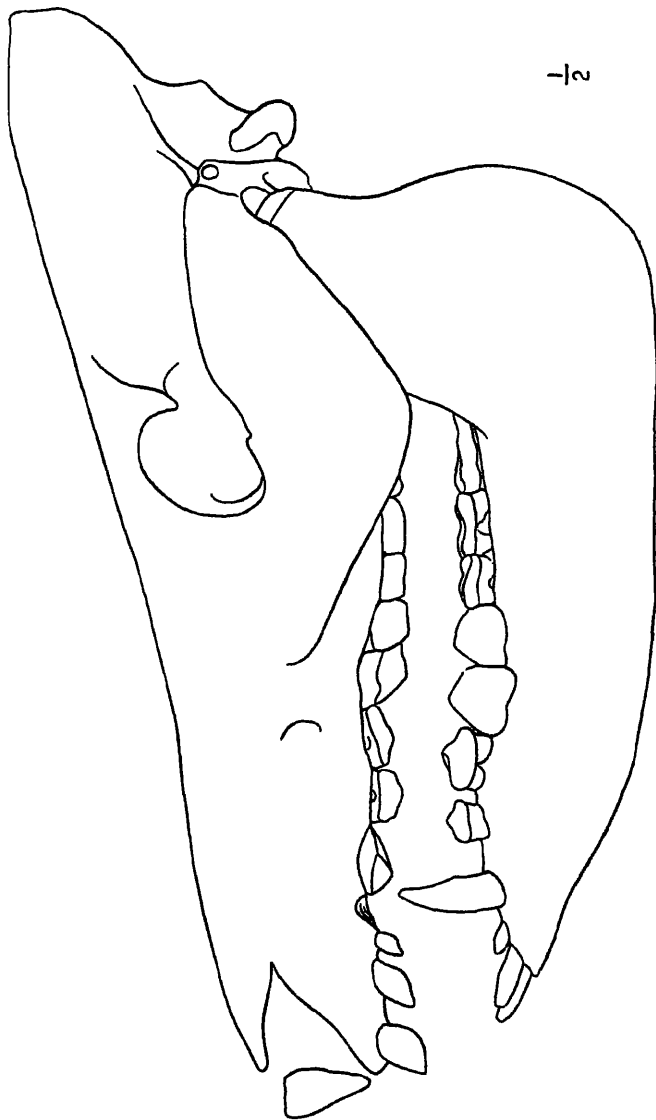


Fig. 5.—*Conohypus sudanense* (Lydekker) Restoration of skull and mandible, based on Amer. Mus. Nos 19616, 19739, 19886, and figures by Filhol, Pearson and others. The shape of the os rostri is hypothetical. One-half natural size.

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BRAINCASTS OF *PHENACODUS*, *NOTOSTYLOPS*, AND *RHYPHODON*¹

BY GEORGE GAYLORD SIMPSON

The brain is the most important single mammalian organ, and knowledge of any extinct group must be considered very inadequate until it includes some data on the endocranial anatomy. The interest and value of endocranial casts are generally recognized, but their study and description have perforce been rather unsystematic and have not often been correlated with the general course of morphological and phylogenetic investigations. Fossil braincasts are relatively rare and must inevitably be even less common than good skulls and incomparably more rare than good dentitions. The recent comprehensive and invaluable review by Edinger (1929) serves not only as a basis for continuing and systematizing research on braincasts but also as an indication of the more serious gaps in present knowledge.

One of the most important of these gaps concerns the native South American ungulates. In spite of voluminous osteological and dental studies by Ameghino, Scott, Sinclair, and many others, almost nothing has been known of the brain in these groups. Gervais (1872) gave a cursory description and one figure each of the braincasts of two Pleistocene genera, *Tyotherium* and *Torodon*, and I (1932) have briefly discussed very poor natural casts of the Eocene *Notostylops* and *Oldfieldthomasia*. Nothing has been published on braincasts of other groups; in particular, nothing has been known in this respect of any member of the abundant and important Order Litopterna.

It is now possible to describe and illustrate good braincasts of typical members of four major groups of South American ungulates. The *Notostylopidae*, commonly referred to the *Entelonychia* but not typical of that suborder, are represented by *Notostylops*, the homalodontotheres, or typical entelonychians, by *Rhyphodon*, the *Tyotheria* by *Hegetotherium* and *Protyotherium*, and the *Litopterna* by *Proterotherium*. The specimens of the first two genera were collected by the Scarritt Patagonian Expedition. Those of the last three were collected by Barnum Brown in 1899 and were described in the Princeton reports, but brain-

¹Publications of the Scarritt Patagonian Expedition, No. 15

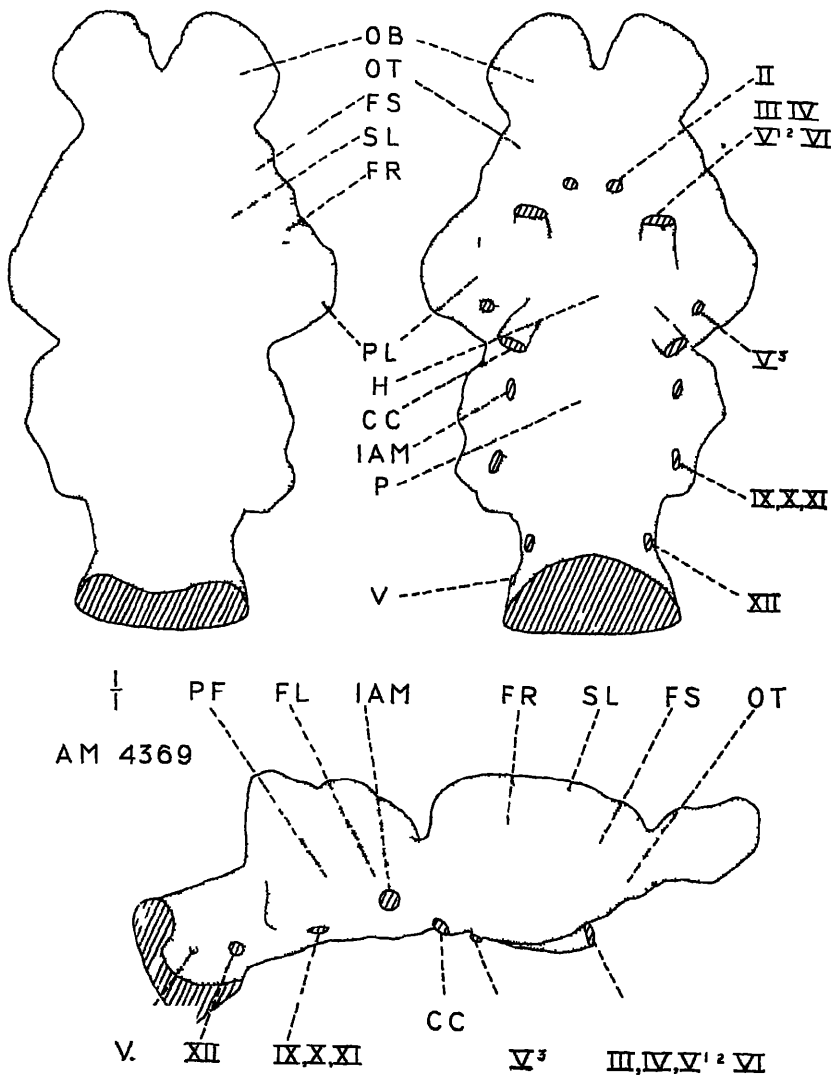


Fig. 1.—*Phenacodus primaevus* Cope. Braincase from Amer. Mus. No. 4369. Dorsal, ventral, and right lateral views. Natural size.

casts were not previously made and are now prepared and studied as part of the research program of the Scarritt Expedition.

In the present paper the braincasts of *Notostylops* and *Rhyphodon* will be described, and as a basis for the study of ungulate braincasts in general, the already fairly well known cast of *Phenacodus* is redescribed and more thoroughly illustrated. In a second paper, to follow immediately, the other South American braincasts are described and the general results given.

It is assumed that the usual conventions of braincast description are accepted. A paleontological braincast, of course, is not a cast of the brain but a mold of the endocranial cavity. In some points it closely approximates the brain but in others may differ widely. The degree and nature of this relationship are generally understood and need not be discussed here. Edinger has admirably summed them up in her comprehensive work.

The casts described in this and the following paper are all artificial, and except for that of *Phenacodus*, made for Cope fifty years ago, were skilfully prepared by Otto Falkenbach. Flexible glue molds were taken from the cleaned cranial cavities, and these were reproduced in plaster for study and preservation. The drawings are by Mildred Clemans. These are diagrammatic to the extent that one side has been used to supplement the other and that artifacts or postmortem injuries are ignored so far as safely possible. Such semidiagrammatic drawings more clearly and accurately represent the original structure than would purely objective reproductions of the casts with all their inevitable accidental imperfections.

Phenacodus

The braincast of *Phenacodus* is of exceptional importance because of its generalized ungulate character. More nearly than any other yet known, it seems to represent the ancestral condition for ungulates in general, as is attested not only by its own structure but also by the broadly proto-ungulate character of the dental and osteological anatomy of this genus. Although in general archetypal, *Phenacodus* is not, of course, really and literally an ancestral ungulate, and the braincast, as well as other features, shows some diagnostic characters of a natural group Condylarthra. These are in part due to the relatively late retention of primitive characters. but in part, and to an extent difficult to define at present, they are more particular and characteristic.

The cast here described is an artificial cast of *Phenacodus primaevus*,

Amer. Mus. No. 4369, and the identical specimen has already been described and figured by Cope (1884), Edinger (1929) and Tilney (1931). In spite of this extensive previous work, the cast is still capable of yielding new facts, especially as full advantage has not previously been taken of the possibility of comparing the cast with the skull from which it came. It may also be useful to gather together all the available data on this crucial form. Cope's description was somewhat cursory and he left many essential features unidentified. Miss Edinger based her work on Cope, nevertheless making some new observations, but falling slightly into error through lack of the original specimen. Tilney was concerned chiefly with the broader features of the cast and did not consider all its details.

Dorsally the cast is very clearly divisible into its three main parts, olfactory bulbs, cerebral hemispheres, and cerebellum, which are arranged serially. The ratio of their lengths is about 2:4:3. The total length (excluding the medulla) is about 70 mm., and the length of the skull was about 237 mm., giving an index¹ of 30. Flexure is very slight: a line continuing the central axis of the medulla oblongata would emerge at the dorsal surface only at the anterior end of the cerebral hemispheres, and one continuing the lower contour of the medulla would emerge at the anterior tips of the olfactory bulbs. Except, probably, for part of the midbrain, none of the dorsal surface has been covered by the expanding neopallium.

The rhinencephalon is very strongly developed, both in bulk and in area constituting well over half of the forebrain. The olfactory bulbs are large and well separated from each other by a median anterior notch. They are divergent, thickened at the anterior end, slightly compressed dorsoventrally, and attached to the cerebrum by short heavy peduncles. As noted by Tilney, obliquely transverse crests on the dorsal surfaces mark the limits of the fibers of the olfactory nerves. Flattened surfaces facing antero-ventro-laterally lay against the cribriform plate. Ventrally a deep triangular fossa, open anteriorly but sharply bounded posteriorly, separates opposite peduncles and the anterior halves of the olfactory tubercles. The latter are distinctly visible as a pair of rather gentle, nearly circular swellings.

The pyriform lobes are even larger than the olfactory bulbs and are visible in dorsal view at the posterolateral parts of the cerebrum, where they form the greatest transverse expansion of the brain.

¹Brain length $\times 100$
Skull length

Even the neopallium is distinctly narrower anteriorly than posteriorly, but less so than the cerebrum as a whole, due to the strong posterolateral extension of the pyriform lobes. The longitudinal scissure is of remarkable depth and breadth, without distinct signs of the vascular sinus, giving so peculiar an aspect that I suspect it of being in part artificial.¹

Cope described four convolutions, or gyri, of the cerebrum, stating (1884, p. 441) that "there are three on each side above the sylvian convolution [sulcus?], and a fourth extends from the sylvian upwards and posteriorly below the posterior part of the third or external convolution . . . the internal and external convolutions unite anteriorly, passing round the extremity of the median convolution." Tilney (1931, pp. 455-458) sees doubtful evidence of a single secondary sulcus, the sulcus lateralis, and tentatively considers the hemispheres to have a lateral [or marginal], a supra-sylvian, and an ectosylvian convolution. The interpretation must be in part subjective, for the surface is vaguely irregular without a definite, indubitable pattern. The presence of a sulcus lateralis may be taken as highly probable, and of another sulcus, perhaps a suprasylvian, as possible. The fourth convolution of Cope seems to lie below the rhinal fissure as tentatively recognized by Tilney and by me, and is probably only accidentally (and certainly only very vaguely) separable from the pyriform lobe.

The rhinal fissure seems fairly well defined on the right side, but is very doubtfully recognizable on the left. The fossa sylvii forms a distinct emargination, anterior to the middle of the hemispheres, but is not definitely bounded. It does not appear to be continued into a sulcus.

The fossa hypophyseos was not marked, there being in this region only a broad and gentle convexity. Elinger was misled by the shading of Cope's figure and identified as the hypophysis a light median spot which, in fact, represents not a projection on the cast but a sharp depression posterior to the hypophysis, that is, the depression caused by the posterior clinoid processes.

Cope noted the probability that the corpora quadrigemina were exposed in the prominent space between the cerebrum and cerebellum, but as is almost always true of braincasts, they have left no impression on the bone.

The large cerebellum has well distinguished vermis and hemispheres. The vermis is sharply divided into a large, oval, gently convex

¹The corresponding bone surface is now visible only obscurely, as it has been so firmly included in the skull reconstruction that the braincase could not again be laid open without serious damage.

anterior lobe and a sharp, conical posterior lobe. On the occipital face is at least one more vague transverse fissure or sulcus. The upper surface of each hemisphere is an irregular plate sloping forward, and ending posteriorly at a fairly sharp angulation between it and the occipital surface. Anterolaterally it is produced into a descending process, elongate anteroposteriorly, lodged in the petrosal, nominally a flocculus.¹ From the posteroexternal angle of the hemisphere another process descends steeply, inclined slightly backward, along the posterior edge of the petrosal fossa, ending at the posterior lacerate foramen.

The pons is indicated by a gentle convexity beneath the anterior part of the cerebellum. The medulla oblongata is nearly smooth and has no surface features of interest.

The nerve exits are all well shown either on the cast or on the original skull. The area of origin of the olfactory fila has already been described. The optic chiasma forms a small swelling on the midline posterior to the olfactory tubercle.

The two optic nerves have distinct but small exits about 4 mm. apart. Along the medial side of the basal aspect of each pyriform lobe, a large ridge, filling of a groove and canal, curves forward and slightly inward, ending in a free projection (filling of a foramen) at the anterior end of the lobe, separated by about 12 mm. from its opposite homologue. These are the courses of III, IV, V₁₋₂, and VI, leading to the anterior lacerate foramen. On the posterior ventral surface of each pyriform lobe, external to the beginning of the large passage just mentioned, is a much smaller, circular, nearly vertical stalk, representing V₃. The internal auditory meatus (VII and VIII) does not show on the cast, but can be recognized in the skull, in the midst of the petrosal (petrosal fossa of the cast) beneath the anterior part of the flocculus. The posterior lacerate foramen (IX, X, XI, and vessels) is large and at the postero-inferior angle of the cerebellum. The condylar foramen (XII), not visible on the cast but clear on the skull, is single and lies at about the middle of the medulla slightly ventral to its most lateral part.

There are only two pairs of impressions definitely and exclusively of vascular origin. On the ventral surface near the junction of fore- and hindbrains, or ventrolaterally between the petrosal fossa and the pyriform lobe, on each side, a large canal begins and curves inward and forward to merge with the convexity of the infundibular region. These

¹As in most braincasts, the surface detail is insufficiently impressed on the bone for determination of the precise minor structure and convolutions, and hence the exact homologies must remain doubtful. It is necessary to use a somewhat more vague and general nomenclature than that now applied to the details of recent cerebella. This part lodged in the petrosal, for instance, has usually been and may well be called the "flocculus," although it is not strictly or exclusively a true flocculus in every case.

impressions doubtless represent the entocarotids and are large and prominent. Another and much smaller vascular canal is indicated on the medulla, dorso-posterior to the exit of XII¹. Those of the two sides are not quite symmetrical.

In résumé, the outstanding features of this braincast are:

1. Great length relative to width, the width being contained in the length (exclusive of the medulla) 1.57 times.

2. Full dorsal exposure of olfactory lobes and cerebellum and probable partial exposure of corpora quadrigemina.

3. Large relative size of olfactory bulbs and cerebellum, the dorsal lengths of the bulbs, cerebral hemispheres, and cerebellum being in about the ratio 2:4:3.

4. Nearly serial arrangement of the principal parts.

5. Relatively strong development of the whole rhinencephalon and small neopallium

6. Slightly gyrencephalic cerebrum.

7. Cerebral hemispheres as a whole strongly pyriform or triangular in outline, with the greatest width posterior.

The principal dimensions are:

Length of skull (slightly restored) . . . . .	...ca. 237 mm.
Total oblique dorsal length of braincast, including medulla oblongata.	82.5 mm.
Length between verticals, exclusive of medulla.	70 mm.
Length of olfactory bulbs.	15 mm.
Width across olfactory bulbs	30 mm.
Length of cerebral hemispheres	30 mm.
Width across cerebral hemispheres (pyriform lobes)	44.5 mm
Length of cerebellum (vermis).	24 mm
Width of cerebellum (flocculi).	36.5 mm.
Minimum width of medulla.	19 mm.

Notostylops

I have elsewhere (Simpson 1932) described a partial natural braincast of *Notostylops*. The natural cast (Museo Nacional, Buenos Aires, No. 10506) had the cerebellum very poorly preserved and did not reveal the ventral surface or any nerve exits, and the present specimen is therefore much more satisfactory, although also imperfect in some details. The two specimens differ somewhat, most obviously in the greater post-cerebral length of the present cast. In this respect I believe it to

¹Cope (1884, p 437) was doubtless referring to this when he said, "the *F. condyloideum* enters the foramen magnum at the middle of its side, and is small. . . ." This is not the anterior condylar-foramen, or hypoglossal canal, which does not show on the cast (although well preserved on the skull) and has not previously been identified.

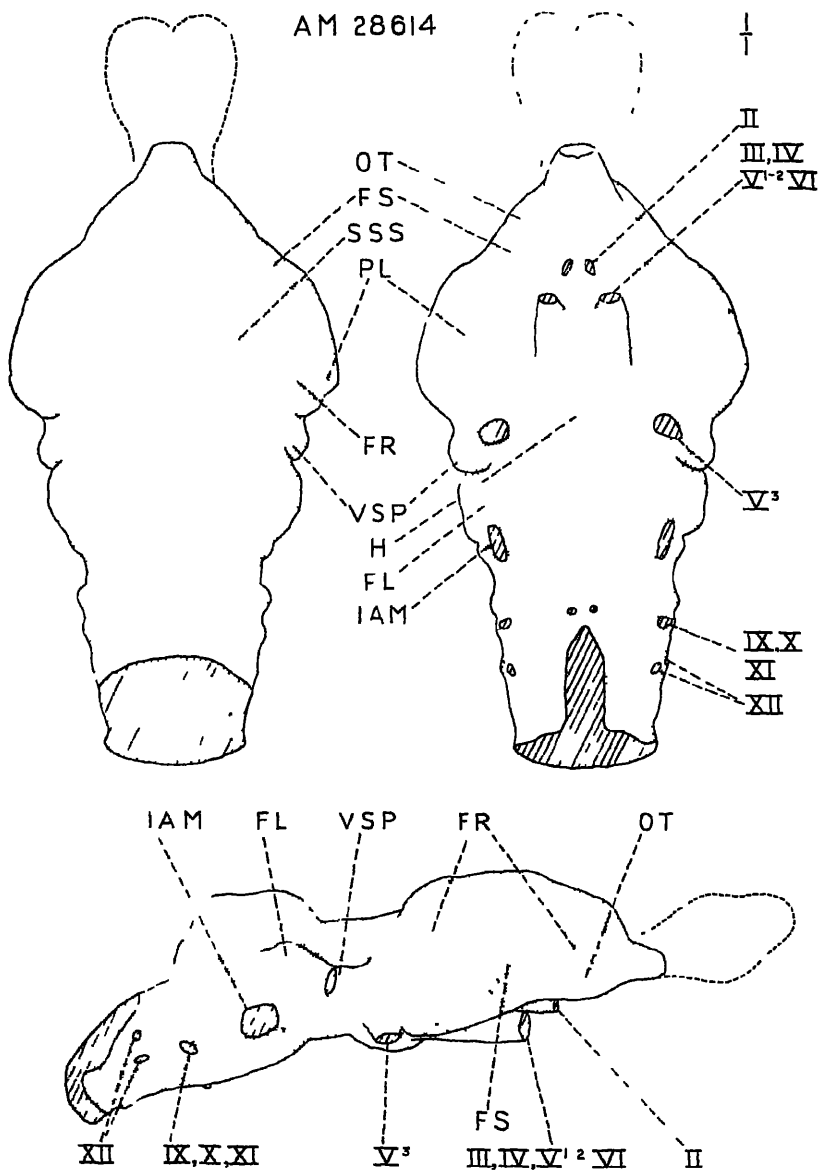


Fig. 2.—*Notostylops* sp. Braincase from Amer. Mus. No. 28614. Dorsal, ventral, and right lateral views. One and one-half times natural size.

be more primitive and perhaps more typical of the whole genus, although perhaps a little exaggerated. The causes of this disagreement are probably four-fold: (1) the species are different, the present cast being from a species evidently more primitive in characters other than the braincast, (2) the individuals are of different ages, the Buenos Aires specimen older at time of death, (3) the preservation and mode of preparation is different and both are somewhat crushed, in different ways, and (4) in details such as size and clarity of vascular impressions, etc., there was doubtless large individual variation.

This specimen is an artificial endocranial cast of a skull of *Notostylops*, Amer. Mus. No. 28614, found by me in Cañadón Vaca, Chubut, Argentina. It is somewhat crushed dorso-ventrally, most of the left side is lacking, and it was not possible to free the olfactory bulbs, which were very difficult to reach with tools and were filled with barite crystals. Yet all the essential characters posterior to the olfactory bulbs are well shown.

The estimated total length of the skull is 115 mm., and of the brain, exclusive of medulla, 55 mm., giving an index of 48. Even apart from the influence of brain structure, this larger index does not necessarily indicate a larger effective brain capacity than in *Phenacodus*. *Phenacodus primaevus* is twice as large in linear dimensions, and larger animals have relatively smaller brains, other things being equal, and it also has an elongate snout, tending to give low index, while that of *Notostylops* is abbreviated, tending to give a high index. The effective brain size, if a name may be applied to a factor so elusive and so impossible to separate from other and even more important factors of brain development, was probably about the same in the two animals.

The serial arrangement is about as in *Phenacodus* and the flexure is, if anything, slightly less. Olfactory bulbs and cerebellum are as fully exposed, and the midbrain apparently even more so. The ratio of olfactory bulbs, cerebrum, and cerebellum was about 2:4:2, the difference from the 2:4:3 of *Phenacodus* being due to the large dorsal gap between cerebrum and cerebellum, part of which doubtless belongs to the cerebellum although not included in its measurement.

The rhinencephalon is very strongly developed, as in *Phenacodus*. In the Buenos Aires specimen, and also in this as far as can be judged from the skull, the olfactory bulbs are comparable to *Phenacodus* in bulk, but longer, narrower, less divergent, and with more slender peduncles. The olfactory tubercles are relatively even larger and more definite than in *Phenacodus*. The pyriform lobes are equally large and

prominent, but this is due rather to their expansion vertically and posteriorly than to their dorsal exposure, or lateral expansion, for in dorsal view they are more limited than in *Phenacodus*, and chiefly posterolateral and posterior rather than definitely lateral to the neopallium.

The neopallium is even more distinctly triangular than in *Phenacodus*, with the anterior end much narrower than the posterior. The longitudinal scissure is well defined, but not so abnormally developed as in *Phenacodus*, and a vague trace of the venous sinus, at its posterior division point, is visible. The nearly straight and horizontal rhinal fissure is distinctly recognizable. The region of the fossa sylvii is a large ventrolateral depression, and from it a broad, short fissure extends upward and backward. Still more posteriorly, on the posterior part of the neopallium, is a broad and vague depression or sulcus apparently running forward and inward to or toward the upper end of the fissura sylvii, but the details are not impressed on the bone with sufficient definition to determine their exact relationships. On the present specimen there is very vaguely visible but on the Buenos Aires specimen quite distinctly developed, a simple, sagittal sulcus lateralis. The neopallium thus has two longitudinal dorsal gyri, marginal and suprasylvian, and distinct frontal and temporal lobes, the latter larger.

In the Buenos Aires specimen a large blood-vessel follows approximately the course of the rhinal fissure. What may be the homologous vessel in this specimen seems to be faintly indicated at the posterolateral corner of the cerebrum, immediately below the rhinal fissure. A small vessel ascends the anterior surface of the temporal lobe, just behind the fissura sylvii.

A round median swelling on the ventral surface, between and slightly posterior to the pyriform lobes, indicates the fossa hypophyseos, which is considerably more definite than in *Phenacodus*.

Laterally the flocculi and pyriform lobes are only about 2 mm. apart, but dorsally, between the anterior end of the vermis and a line tangent to the posterior ends of the temporal lobes, about 6.5 mm. intervenes between cerebrum and cerebellum. In this space is a broad, roughly rectangular, almost flat, depressed area. Here the midbrain must have been exposed, and the corpora quadrigemina were probably clearly visible in the dorsal view of the original brain, but they have left no impression on the bones. Probably part of the cerebellum underlay this area also, but in this specimen, not yet fully adult, it had not yet modeled the overlying bone.

The cerebellum is clearly divided into a large vermis and relatively

very small hemispheres. The vermis is divided by two real but indefinite transverse sulci into three lobes. These are probably the true anterior, median (simplex), and posterior (posteromedian) lobes and their divisions the fissura prima and fissura secunda, but this is not absolutely certain, as these primary cerebellar fissures are not invariably more prominent than secondary sulci. The anterior lobe is evenly convex and nearly circular in section. The median lobe is also featureless (in the cast), confined to the dorsal surface, and is transverse, about half as long as the anterior lobe. The posterior lobe has about the same length as the anterior, but is less even, with vague traces of transverse sulci, and lies almost entirely on the more vertical occipital exposure of the cerebellum.

The cerebellar hemispheres are very vaguely divided into anterior and posterior moieties on the dorsal and occipital surfaces. Below the anterior part and extending still farther forward is the strongly developed "flocculus," elongated anteroposteriorly. From the posterior lobe of the cerebellar hemisphere, a sharp crest runs downward and backward, bounding the posterior end of the petrosal fossa.

The region of the pons is peculiarly marked by two well defined longitudinal ridges.

The nerve exits are all well shown. The optic chiasma and optic canals occupy the same positions as in *Phenacodus* and the strong canal for III, IV, V₁₋₂, and VI, leading to the anterior lacerate foramen, is also very similar although relatively slightly closer to the midline. V₃ also has the same position and relationships as in *Phenacodus*. The large internal auditory meatus (VII, VIII) is ventral to and in part slightly posterior to the flocculus, near the center of the well defined periotic fossa. Posterior and slightly ventral to it, at the lower end of the post-periotic crest from the cerebellar hemisphere, is the relatively small posterior lacerate foramen (IX, X, XI), quite as in *Phenacodus*; XII also is as in *Phenacodus*, except that it has a second smaller and more dorsal root.

In or near the fossa sylvii there appears to be a small vascular foramen, not very clearly or certainly shown because of slight breakage in this region. The strong entocarotid vessels seen in *Phenacodus* are here absent, doubtless displaced by the development of the bullae. There is a pair of small vascular foramina in the basioccipital near the midline, slightly anterior to the level of the posterior lacerate foramen.

The most prominent vascular opening is directed backward from the posteroexternal angle of the cerebrum, just below the rhinal fissure.

I was at first inclined to consider this an artifact, but its presence and clearly natural character in the Santa Cruz typotheres (see below) confirms its reality as an original endocranial feature. From it comes the great blood sinus so prominent near or on the rhinal fissure in the Buenos Aires specimen and also present, but less obvious, on the present cast. This prominent venous foramen apparently communicates with the epitympanic sinus, the postglenoid foramen, or both. Its relationships may be cleared up more fully by a detailed study of early notoungulate skull structure now in progress. It seems to be an important and unusual character.

Despite the inevitable differences of preservation, the brains of *Phenacodus* and of *Notostylops* are seen to be remarkably similar. The general proportions, degree of development, and many details are closely comparable and the differences are mostly minor and not greater than may commonly be seen between the braincasts of members of a single family. While the skull of *Notostylops*, and its teeth, have been rather strongly modified, the brain is conservative and clearly has progressed hardly at all beyond the primitive ungulate type, apparently also retaining evidence of some special affinity with *Phenacodus*, or with the *Condylarthra* in general.

Among the numerous details in which *Notostylops* differs from *Phenacodus*, the following seem to be the most definite and important:

1. Braincast slightly longer in proportion to its width.
2. Olfactory bulbs of different shape (see above).
3. Pyriform lobes extending somewhat more posteriorly and less laterally.
4. Neopallium more triangular in outline.
5. Gyri probably developed in much the same pattern and to about the same degree, but some difference in detail not excluded by the known material.
6. Fossa hypophyseos relatively deeper and more distinct.
7. Cerebellum shorter relative to cerebrum
8. Pons underlain by two longitudinal ridges (vessels?).
9. Hypoglossal canal double (at internal end).
10. Course of entocarotid different.
11. Large vascular opening at posterolateral angle of cerebrum

Several of these characters, perhaps most of them, are due to or related to relatively superficial habitus changes, shape of skull, development of bullae, etc., rather than to any more deep-seated or phyletic distinction.

The principal dimensions are:

Length of skull (estimated, rostrum imperfect)	ca. 115 mm.
Length of braincast exclusive of medulla (estimated, olfactory bulbs absent)	ca. 55 mm.
Length of olfactory bulbs (estimated ¹)	ca. 12 mm.
Length of cerebral hemispheres	23 mm.
Width across cerebral hemispheres (pyriform lobes).	30 mm.
Length of cerebellum (vermis)	13 mm.
Width of cerebellum (flocculi)	23 mm.

Rhyphodon

The little-known genus *Rhyphodon* Roth (with its equally neglected synonyms *Pehuena* and *Setebos*) is represented by fairly good skulls and dentitions in the La Plata collection, but has been described only in the briefest fashion, and only the upper dentition ("*Pehuena wehrli*") has been figured. It is a homalodontothere, probably not directly ancestral to *Homalodontotherium* but a member of the same family. Its brain may be considered representative of the early true entelonychians (in the most limited sense).

The present braincast is from a partial skull, Amer. Mus. No. 29414, found by C. S. Williams in the *Astraponotus* Beds near the Cerro del Humo, north of the Cuenca de Sarmiento, Chubut, Argentina. I believe this to be the type locality of *Rhyphodon lankesteri* and its synonyms. Roth labeled them as from the Cretaceous of Lago Musters, but for reasons too lengthy to detail here, it seems almost certain that they are really from the *Astraponotus* Beds (Eocene or possibly early Oligocene) of the Cerro del Humo. This skull has the complete cranium, also much of the right frontal, nasal, and premaxilla, and a fragment of the maxilla, without any teeth. Identification is not certain, but it is surely a very close relative of *Rhyphodon* and probably belongs to that genus, perhaps to its type species, *R. lankesteri*. The bone is very brittle and chalky and the cranium somewhat broken and eroded, but most of the essential characters of the braincast are determinable by comparing the two sides and the skull. The cast is artificial, taken by sawing the cranium on the midline in a vertical sagittal plane.

The total length of the skull (slightly crushed and tip of premaxilla missing) was about 230 mm., and of the brain, exclusive of the medulla, about 85. The index is thus 37. Allowing for the large size (tending to give a small index) and the short rostrum (tending to give a large index),

¹This cannot be far from the correct measure, as both anterior and posterior boundaries are visible in the skull, although the distance between them cannot be measured directly or exactly, and the ratio is about as in the Buenos Aires specimen

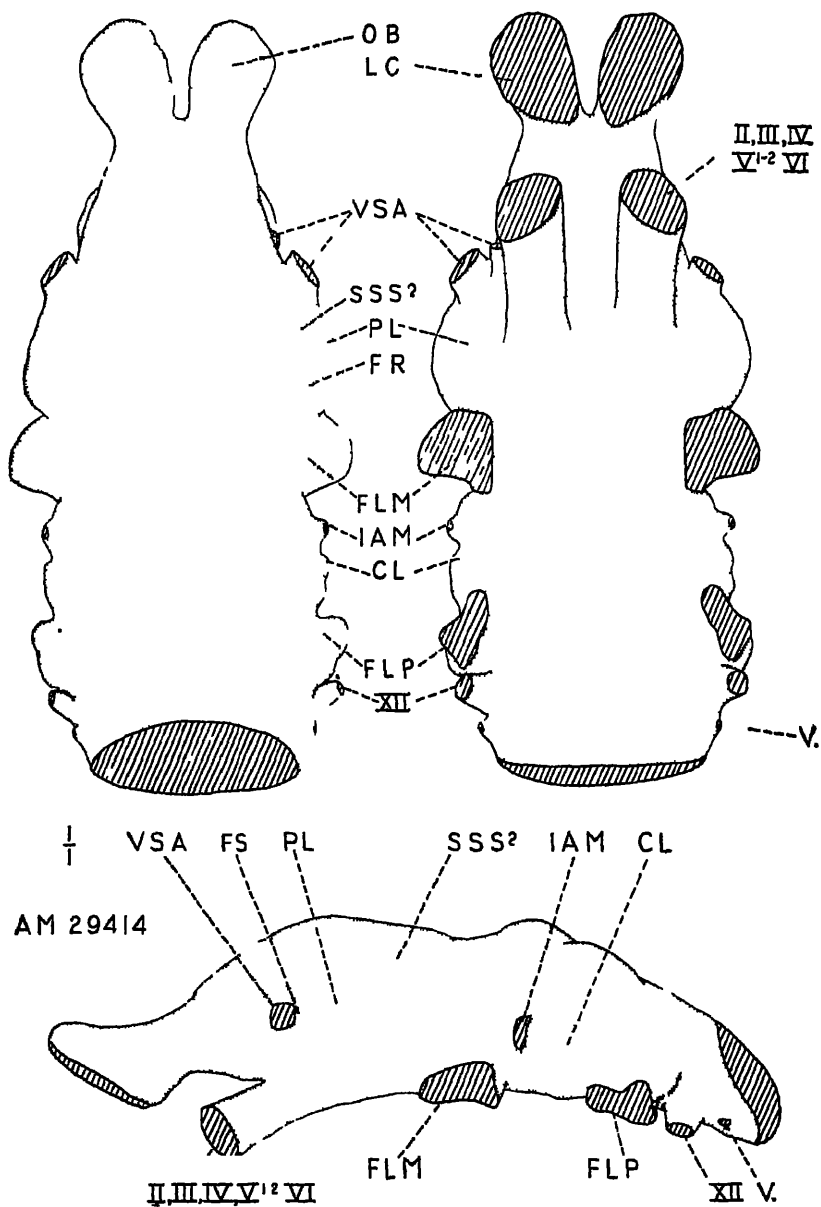


Fig 3—*Rhyphodon* sp Brauceast from Amer Mus No 29414. Dorsal, ventral, and left lateral views. Natural size

and for the general proportions of the brain itself, this probably indicates an effective brain size not significantly different from *Notostylops* (48, made large by small size and short rostrum) or *Phenacodus* (30, made small by large size and long rostrum), so far as such a necessarily very rough estimate can be made.

The arrangement seems to be about as serial as in *Phenacodus* or *Notostylops*, and the flexure about as in the latter, except that the olfactory bulbs are bent downward (they are overlain by large frontal sinuses absent in the other genera here described). The ratio olfactory bulbs: cerebrum: cerebellum is roughly 3:8:6, rather closely paralleling *Phenacodus* or *Notostylops*, but with relatively somewhat smaller olfactory bulbs. The maximum cortical width is contained almost exactly twice in the length, making the brain as a whole relatively more elongate than in *Phenacodus* and less than in *Notostylops*. The most unusual feature of the general proportions is that the cerebellum is almost as wide as the cerebrum.

The olfactory bulbs, fully exposed and large although relatively smaller than in *Notostylops*, are of almost equal width, length, and depth. They are completely separated by a deep narrow fissure, which does not, however, split the strong peduncles. The olfactory tubercles, while visible, are not prominent and are more poorly defined than in *Notostylops*. The pyriform lobes are about as prominent as in *Phenacodus* or *Notostylops*, or possibly slightly weaker relatively, and are visible in dorsal view, extending laterally to the neopallium as in *Phenacodus* rather than posteriorly as in *Notostylops*.

The neopallium, while longer and narrower than in *Phenacodus*, has the less strongly triangular outline of that genus, the anterior and posterior widths being less disparate than in *Notostylops*. The rhinal fissure is nearly straight, continuous, and horizontal. The fossa sylvii is placed as in *Notostylops*. Imperfections of the bones make it impossible to say whether it is produced into a fissure, but if present this must have been shallow and short. The neopallium is almost perfectly smooth, the only evidence of a sulcus being a short, straight, very shallow and vague longitudinal depression 6 mm. above the rhinal fissure and about 15 mm. from the midline. If this is a sulcus, it seems to correspond more nearly with the (nominally) suprasylvian sulcus of *Notostylops*. If this is true, its development without a sulcus lateralis is unusual, and if it is the sulcus lateralis, its very lateral position is even more extraordinary. The region of the hypophysis is imperfect, but it is evident that the fossa hypophyseos was even smaller and shallower than in *Phenacodus*.

There is a depressed dorsal area between cerebrum and cerebellum, and the midbrain may have been exposed, but if so, the exposure was small.

The whole cerebellar region is very vague and lacks definite character; this is in part due to the imperfection of the bone surface, but even where this is completely preserved the sculpture is slight and indefinite. The occipital exposure is strongly inclined forward and not distinctly differentiated from the dorsal exposure, as it is in *Phenacodus*, *Notostylops*, or indeed most other mammals. Near the junction of these two planes, a division into a large vermis and smaller hemispheres is vaguely seen, but otherwise these surfaces lack definite characters. In lateral view there is a very marked difference from *Phenacodus*, *Notostylops*, and most other primitive ungulates in that there is a lobe of the cerebellum lodged in a fossa of the petrosal posterior and slightly ventral to the internal auditory meatus but very little or probably none dorsal or dorsoanterior to the meatus in the region of the flocculus. I am unable to homologize or interpret this condition, but it seems to be indicated by unbroken bone surface in the skull. As in *Phenacodus* and, less markedly, *Notostylops*, another descending lobe or fissure filling curves to the foramen lacerum posterius around the posterior margin of the petrosal fossa.

The cranial exits are remarkable. There is no definite indication of the optic chiasma, and no trace of an optic canal or foramen can be seen. The optic nerves must have left the brain in a common tunnel with the other nerves destined for the orbit, III, IV, V₁, and VI. But in *Pleurostylodon*, a more primitive relative of *Rhyphodon* from the *Notostylops* Beds, there is a separate optic foramen. The condition in *Homalodon-totherium* and other later entelonychians is unknown to me.

The paired projections leading to the anterior lacerate foramina are of enormous size. They carried a complex of nerves, certainly III, IV, V₁, and VI and almost surely also II and V₂. Their compound nature is indicated by a longitudinal groove on the ventral face of each. The stalks representing the median and posterior lacerate foramina are larger on the cast than they would be had not the tympanic bulla been destroyed and a large postmortem gap created between the periotic and the basioccipital-basisphenoid. V₂ clearly passed out through the gap now confluent with the median lacerate foramen, but doubtless had a more exclusive exit when the bone was complete. As usual, IX, X, and XI undoubtedly left through the posterior lacerate foramen. The internal auditory meatus, VII and VIII, is at a relatively high position,

more on the lateral than on the ventral surface of the cast; XII is large and is immediately posterior to the posterior lacerate foramen.

In the region of the fossa sylvii on the left side is a heavy stalk, representing a skull canal which branches in the bone and appears externally as two foramina, a smaller one immediately above the anterior lacerate foramen and a larger dorso-postero-external to this. On the right side there are similar foramina on the external surface of the skull, but the canal fillings have separate origins on the cast. This asymmetry may be, but does not seem to be, due to breaking away of the common part of the canal on the right side. Attempts were made to homologize these with nerve exits, and particularly to homologize the smaller foramen with the optic foramen, but the point of origin on the cast, the course and branching of the canal, and the position of the external foramina would all be so anomalous for cranial nerves that this hypothesis is hardly tenable. These unexpected and prominent canals are more probably of vascular origin. This is also supported by the presence of similar but variable openings in this region in *Pleurostylodon* and some other early entelonychians, even more difficult to interpret as anything but vascular. The possible (but uncertain) occurrence of a very much smaller single opening in the same region in *Notostylops* suggests correlation with this condition, but on such poor data as to be only a suggestion. In any case the difference between the two is very marked. The prominent posterolateral vascular passage from the cerebral chamber in *Notostylops* (and some typtotheres) is absent in *Rhyphodon*.

By classifications currently accepted, *Notostylops* and *Rhyphodon* belong to the same suborder, Entelonychia, while *Hegetotherium* and *Prottyptotherium* belong to a different suborder, Typtotheria. The braincasts do not support this arrangement. Whether other and possibly more important characters do make this classification acceptable may be discussed elsewhere, and it suffices here to record that the typtothere braincasts examined are more specialized (as they are younger) but seem to agree basically with *Notostylops*, while the braincast of *Rhyphodon* is equally unspecialized but seems to differ significantly from that of *Notostylops*.

Among the differences from *Notostylops* are:

1. Olfactory bulbs relatively smaller.
2. Olfactory bulbs bent downward.
3. Cerebellum relatively larger and width nearly equal to length.
4. Olfactory tubercles less distinct.
5. Pyriform lobes expanded laterally, not posteriorly.

6. Less disparity between anterior and posterior widths of neopallium.
7. Cerebral hemispheres possibly less and differently convoluted.
8. Flocculus not lodged in petrosal, but a petrosal lobe present posterior to the internal auditory meatus.
9. No separate optic canal, and common canal for III, IV, etc., of enormous size.
10. Large double or branching canal to the outside of the skull in the region of the fossa sylvii.
11. No posterolateral cerebral venous canal

This markedly different character, without departure from about the same primitive developmental level, was altogether unexpected. It will be important to have it confirmed or modified by other entelonychan casts (not at present available to me), but that a decided difference does exist seems to be established.

Some of the dimensions follow:

Width of skull (partly estimated)	ca 230 mm.
Length of braincast (excluding medulla)	85 mm.
Length of olfactory bulb	14 mm.
Width across olfactory bulbs	28 mm.
Length of cerebral hemispheres.	41 mm.
Width across pyriform lobes.	43 mm.
Length of cerebellum	30 mm.
Width of cerebellum (exclusive of expansion at posterior lacerate foramen).	39 mm.

Due to crushing and some vagueness of boundaries, none of these figures is exact.

ABBREVIATIONS ON TEXT FIGURES

- II—Optic nerves (filling of optic canal)
- [II], III, IV, V₁₋₂, VI—The common canal of these cranial nerves, and filling of the anterior lacerate foramen.
- V₃—Mandibular nerve (filling of foramen ovale).
- IX, X, XI—Point of exit of these nerves (filling of foramen lacerum posterius).
- XII—Point of exit of this nerve (filling of hypoglossal canal or condylar foramen).
- C C.—Carotid canal.
- C L.—Cerebellar lobule lodged in petrosal posterior to internal auditory meatus.
- F L.—“Flocculus,” or cerebellar lobule in petrosal anterior to internal auditory meatus
- F.L.M.—Foramen lacerum medium.

- F.L.P.—Foramen lacerum posterius.
 F.R.—Rhinal fissure.
 F.S.—Fossa sylvii.
 H.—Filling of fossa hypophyseos.
 I.A.M.—Internal auditory meatus (nerves VII and VIII).
 L.C.—Surface applied to lamina cribrosa.
 O.B.—Olfactory bulb.
 O.T.—Olfactory tubercle
 P.F.—Petrosal fossa (of cast, not a fossa in the petrosal).
 P.L.—Pyriform lobe
 S.L.—Lateral sulcus.
 S.S.S.—Suprasylvian sulcus.
 V.—Minor vascular foramina.
 V.S.A.—Anterior foramina, probably vascular.
 V.S.P.—Posterior venous passage from cerebral fossa.

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A NEW CROCODYLIAN FROM THE *NOTOSTYLOPS* BEDS OF PATAGONIA.¹

By GEORGE GAYLORD SIMPSON

The Scarritt Patagonian Expedition found remains of crocodiles, for the most part fragmentary, at a number of localities and horizons in Patagonia. Much of this material has not yet been prepared and its final publication must be long deferred, but there is already available a good, identifiable specimen from the *Notostylops* Beds which is of such interest that a preliminary discussion of it is here presented. This form, representing a new genus and species, is of unusual importance not only in itself and as a member of an extraordinarily rich and varied fauna, but also in its bearing on important problems of phylogeny, of paleogeography and faunal origin, and of correlation.

DESCRIPTION

Eocaiman, new genus

TYPE.—*Eocaiman cavernensis*, new species.

DISTRIBUTION.—*Notostylops* Beds of Patagonia.

DIAGNOSIS.—A true crocodilid or alligatorid with broad snout and alligatoroid bite. Pre- and inter-orbital crests as in *Jacaré*. Orbits large and close together. Anterior processes of palatines extending well in advance of posterior palatal vacuities and irregularly quadrate, as in *Caiman* but less elongate. Posterior palatal vacuities relatively wide and short, irregularly oval, the pterygoids forming the whole posterior border. Pterygoids short, and internal nares nearer their anterior than their posterior edges, relatively far forward. Lower jaw shallow but stout, with pronounced undulation of dental border. Symphysis extending about to fifth or sixth tooth, very shallow and wide. Splenial nearly reaching but not entering into symphysis. About fourteen maxillary and nineteen or possibly twenty dentary teeth. Fourth (?) maxillary and fourth and thirteenth dentary teeth much enlarged, the two latter each received in prominent pits in the palate. Posterior teeth pointed and crested, but with relatively depressed and blunt crowns.

Eocaiman cavernensis,² new species

TYPE.—Amer. Mus. No. 3153. Most of the front parts of skull and jaws. Found by G. G. Simpson and J. Hernández.

¹Publications of the Scarritt Patagonian Expedition, No. 14

²The type was found in a cave, in a block fallen from the ceiling

HORIZON AND LOCALITY—*Notostylops* Beds, south of Lago Colhué-Huapi, Chubut, Argentina

DIAGNOSIS—Sole known species of the genus, as defined above and described below

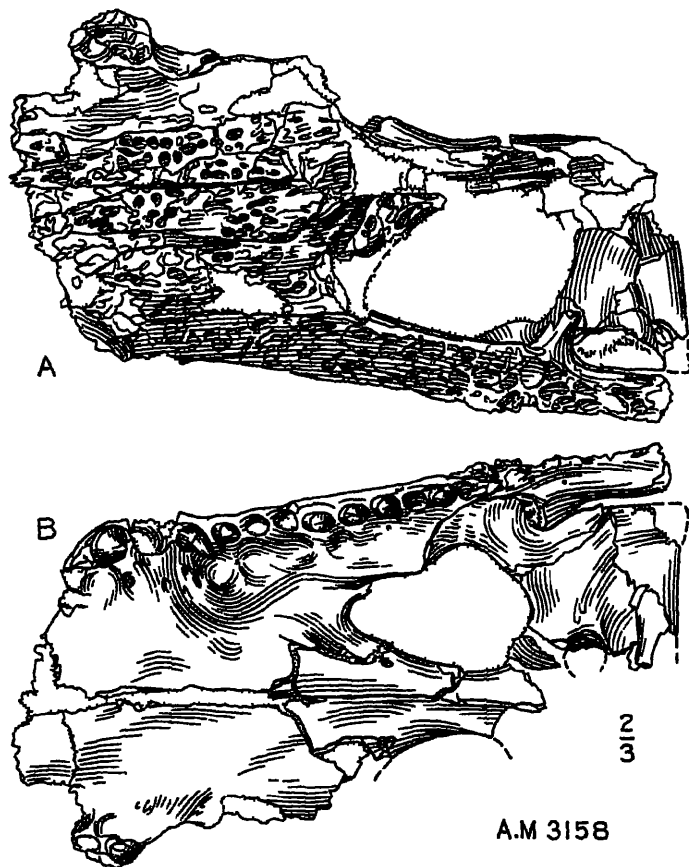


Fig. 1. *Bocsiman cavernensis*, new genus and species.

Type, Amer Mus No 3158 Part of Skull A, dorsal, view B, palatal view Two-thirds natural size Drawn by John Germann

The general contour of the preserved parts is much as in the living yacarés. The orbits, not completely preserved, were clearly very large and unusually long, with the base of the postorbital bar about 35 mm. posterior to the anterior orbital rim This length is also correlated with relatively long and slender anterior or suborbital portion of the jugal.

The tip of the snout, with the external nares and the greater part of the premaxillae, is missing, and the remainder of the face is so much cracked that no details of interest are observed except that there was probably an antorbital ridge and that there is surely a strong semicircular crest between the anterior ends of the orbits as in *Jacaré*.

On the palate, the premaxillo-maxillary suture is nearly transverse in the middle portion, but was doubtless more oblique in the missing

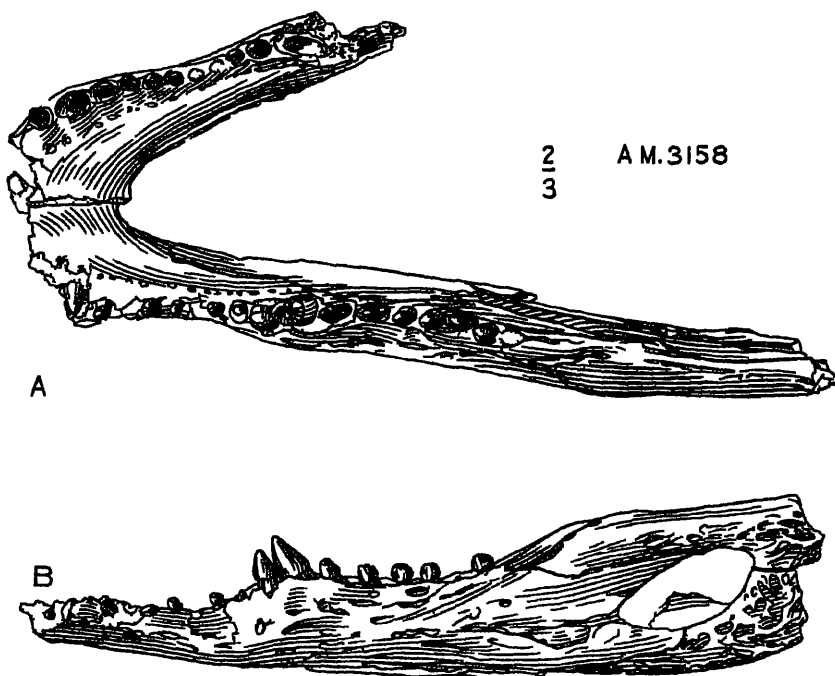


Fig 2 *Eocaiman cawrhensis*, new genus and species

Type, Amer Mus No 3158 Lower jaw A, superior view. B, left lateral view Two-thirds natural size Drawn by John Grinnell

outer parts. The palatine processes of the maxillae are marked by a very deep and prominent rugose pit internal to the fifth to eighth maxillary teeth. The anterior processes of the palatines are irregularly quadrate and extend about 20 mm. beyond the most posterior part of the palato-maxillary suture and about 12 or 13 mm. beyond the anterior end of the posterior palatal vacuities. The latter are about 22 mm. in width and 39 mm. in length and are almost of regular oval contour except for a

projection of the rim at the maxillo-ectopterygoid suture. At the posterior rim, in contrast to yacaré and many other recent crocodilians, the ectopterygoid and palatine are widely separated, so that this rim is formed almost exclusively by the pterygoid. The distance from the external rim to the tooth row is unusually great. The internal narial aperture was more anterior than in modern crocodilians, being closer to the palatal vacuity than to the posterior edge of the pterygoid plates. There were postero-lateral crests on the pterygoid at the narial rims.

The lower jaw is remarkably shallow, but stout transversely. The anterior end is broken, so that it is impossible to ascertain whether it had a median projection or point, but it very possibly did, as the first tooth seems to have been large. The symphysis, extending to about the fifth or sixth tooth, is very wide, flat, and shallow. As shown by its sutures, the splenial nearly reached the symphysis but was not involved in it, much as in *Jacaré*, and the arrangement of the other elements, so far as preserved, is likewise almost exactly as in *Jacaré*. The external foramen is rather large, moderately elongate, with the surangular forming about the posterior third of its upper rim. The dental border rises at the fourth and thirteenth teeth (perhaps also at the first) and posterior to the teeth and sinks between these points, giving it a markedly irregular contour. Anterior to the thirteenth, the teeth are planted along the outer edge of the dental border and even point somewhat externally. The dental border posterior to the thirteenth tooth is depressed and widened, with the teeth near the midline, and there is a tendency to form a small horizontal flange at the upper edge of the splenial internal to the posterior teeth.

The premaxillary teeth are not known. There were probably fourteen maxillary teeth. In numbering them, the very probable assumption is made that there was one more tooth anterior to the thirteen of which crowns or alveoli are definitely visible. The third is a large tooth, considerably larger than the second, and the fourth is still larger, distinctly the largest maxillary tooth. The crown of the third is high, somewhat recurved, and crested. The fifth and sixth teeth are progressively much smaller, the seventh about the size of the sixth, the eighth larger and the subsequent teeth of about the same size until the somewhat smaller thirteenth and fourteenth. At least the ninth to thirteenth have low and bluntly pointed crowns, but laterally compressed and with distinct anteroposterior crests.

There is definite evidence of seventeen lower teeth and it is practically certain that broken bases of alveoli represent two more anterior

to these. Posterior to the definitely visible series is a depression possibly representing another tooth, although this is very uncertain and improbable. There were nineteen or possibly twenty lower teeth. The first was probably enlarged, but this is not wholly certain. The fourth is certainly enlarged and forms a "canine." The fifth is abruptly smaller and they then decrease in size to the ninth or tenth, becoming tiny, pointed but almost spatulate teeth. The eleventh is slightly and the twelfth much larger, while the thirteenth is the largest tooth in the lower jaw (with the improbable exception of the first), apparently even larger than the fourth. The fourteenth is abruptly smaller and the others still smaller and subequal, somewhat smaller and more depressed than the opposite teeth of the upper jaw.

AFFINITIES

A number of fossil crocodiles have been described from South America, but these are almost all of quite different ages from *Eocaiman* and either obviously distinct or so close to living forms as to require no special consideration here.

In 1896, however, Smith Woodward described two crocodiles sometimes considered as of early Tertiary age. These, *Notosuchus* and *Cynodontosuchus*, were listed as from the "red sandstones of . . . Neuquén." The confusion often existing in early collections makes the age uncertain, but the bulk of the material so labeled is surely Cretaceous, and as these genera are themselves of Cretaceous, even early Cretaceous, affinities, the presumption is that they, too, are Mesozoic and not Cenozoic in age. *Notosuchus* was referred to the Gompholidæ. Ameghino (1906, pp. 93-94) reported that *Notosuchus* occurs in some abundance, although always isolated (fragmentary) in the *Notostylops* Beds and in the coastal deposits of the marine Salamanca Formation. This was cited as another proof of the antiquity of the *Notostylops* Beds and their contemporaneity with the Salamanca.

Eocaiman is apparently the common crocodile in the *Notostylops* Beds, and it was probably on fragments of it that Ameghino based his assertion that *Notosuchus* occurs there. It is therefore necessary to compare the two. Fragments could readily be confused, but the good material now available shows that they are very distinct and cannot even have been at all closely related. Among the many differences of *Eocaiman* from *Notosuchus* are the following:

No antorbital vacuity.

Lower jaw more elongate and shallow.

Splenials excluded from symphysis.

Lateral vacuity of mandible smaller and less elongate.

Teeth much more numerous (about twice as many), and differently developed.

Nares (probably both external and internal) more typically crocodilid in structure.

These and many minor differences in the rather few known comparable characters show that the genera are profoundly distinct and have nothing to do with each other, probably not even belonging to the same broad family.

Ameghino's objective evidence for the occurrence of *Notosuchus* in the Salamanca Formation and in the *Notostylops* Beds consists chiefly of the specimens figured by him in 1906, Fig. 21. He did not give their stratigraphic or geographic origin, but the specimens are preserved in the Museo Nacional. The originals of Fig. 21c, d, e, m, n, o, and u, together with an unfigured fragment, are catalogued as No. 10881 and have Ameghino's label "Pico Salamanca Salamanquense." They are therefore from the Salamanca Formation. Although really unidentifiable, there would be nothing remarkable in their belonging to *Notosuchus* as they are from well down in the Cretaceous. The original of Fig. 21a and b is No. 10885 and has conflicting labels. One, not clearly legible, appears to say "Río Chico—en el bajo al oeste [possibly another illegible word follows]—form. [formación?] *Notostylops*. Cocodrilo [?]," and the other says "*Notosuchus terrestris* Pico Salamanca." This single tooth may or may not be from the *Notostylops* Beds, and in any event is not identifiable. It might belong to *Eocaiman*, and there is no good reason for referring it to *Notosuchus* or for considering it the same as the Salamanca crocodile.

Comparison with *Cynodontosuchus* is unnecessary, as that is obviously a long-snouted crocodiloid form very unlike *Eocaiman*.

Among South American crocodiles, none of the known fossils is as close to *Eocaiman* as are the living *Jacaré* and *Caiman*.

In North America, the late Cretaceous (Hell Creek) *Brachychampsia* resembles *Eocaiman* in general form, but the tooth differentiation and some osteological features oppose close relationship. Comparable parts are too few for certainty, but it is conceivable that *Brachychampsia* and *Eocaiman*, while very distinct genera, did have a common ancestry.

Comparison with *Allognathosuchus* of the North American Paleocene and Eocene¹ is of unusual interest. The two are manifestly closely related. The general shape and proportions are similar. The palato-

¹And possibly Oligocene, but, as noted by its author, *Allognathosuchus riggsi* Patterson, 1931, is not a typical member of the genus, and I suspect that it is closer to "*Crocodylus*" *prenasalis* Loomis, which Mook (1932) now refers to *Alligator*.

maxillary and premaxillo-maxillary sutures are nearly the same as far as visible. The posterior palatal vacuties are similarly bounded. The posterior nares occupy about the same position. The symphysis of the mandible is similarly wide and depressed. The peculiar wavy contour of the dental border is almost the same in both, and the shallow, thick dentaries are similar. In both, but, like some other resemblances, in unequal degree, the dental border is flattened and widened and a flange tends to develop internal to the posterior teeth. Except for the anterior end of the splenial, the shape and arrangement of the known mandibular elements are almost the same. The number of teeth is the same or very nearly so, and their differentiation and relative sizes are almost identical in the two genera.

The differences, while of generic value, are not profound. In *Eocaiman* the symphysis was probably slightly shallower and wider. The thickness of the dentary and the development of a dental shelf are not quite so pronounced; the splenial does not distinctly enter the symphysis; the lateral vacuity is relatively slightly larger and more elongate. The posterior palatal vacuties are larger. The anterior ends of the jugal, and probably some other skull elements, are more slender; in fact, the construction throughout is somewhat lighter and less massive, doubtless an adaptive feature of no great significance. The posterior teeth, while rather blunt, fall considerably short of the extreme specialization of *Allognathosuchus* in this respect.

In the development of the posterior teeth and the probably correlated lighter construction of skull and jaws, *Alligator prenasalis* is closer to *Eocaiman* than is *Allognathosuchus*. Yet this Oligocene North American species retains the splenial symphysis and some other minor characters of *Allognathosuchus* already lost or modified in *Eocaiman*. It does not have the pre- and interorbital ridges already present in *Eocaiman*. In many respects, *Alligator prenasalis*, which is a very early and primitive *Alligator* unlike *A. mississippiensis* in many important characters, is more like *Allognathosuchus*, *Eocaiman*, and *Caïman* or *Jacaré* than are the living alligators. But it does appear to be advancing toward typical *Alligator*, and these resemblances are doubtless due to its being less removed from the point of separation of these related phyla.

Caimanoidea Mehl, 1916, was considered by its author to be especially, but collaterally, related to *Caiman*. Reconsideration with the much better data of several sorts now available suggests that *Caimanoidea* is not particularly related to *Caiman* but is nearer the *Alligator* phylum. Details of structure are not very clearly known, but particu-

larly in its less developed and somewhat different dental differentiation, it is even farther from *Eocaiman* than is its contemporary *Alligator prenasalis*.¹

Among living forms, *Eocaiman* surely most resembles *Jacaré* and *Caiman*, or *Caiman sensu lato*. In some respects, such as the slope of the palato-maxillary suture, it is more *Caiman*-like; in others, such as the less elongate snout and prominent interorbital crest, more *Jacaré*-like. In still others, apparently primitive, such as the large participation of the pterygoid in the rim of the posterior palatal vacuity or the more anterior position of the internal nares, it differs from both. In the known parts there seems nothing to exclude *Eocaiman* from the ancestry of both *Jacaré* and *Caiman*.²

CONCLUSIONS

1. *Eocaiman cavernensis* is a new and distinctive alligatoroid form from the *Notostylops* Beds, probably Eocene, of Patagonia.

2. It is apparently the common crocodile of those beds, and is surely very distinct from *Notosuchus*. Contrary to Ameghino, there is no evidence that *Notosuchus* occurs in the *Notostylops* Beds. To that extent, his belief in the antiquity of that formation is thus still further weakened.

3. So far as may be judged on still too scanty evidence, *Eocaiman* is of early Tertiary, probably Eocene, aspect as regards evolutionary advance.

4. *Eocaiman* seems to stand near the ancestry of *Caiman* and *Jacaré*, suggesting that those genera have developed in South America during the Tertiary, and probably independent of other connections since early in or even before that period.

6. Its further apparent relationship with *Allognathosuchus* and with other North American early Tertiary forms strongly suggests that these North and South American alligatoroid genera are a distinctive group of common geographic and zoölogic origin.

¹I formerly (1930) suggested that *Caimanoides*, while not a direct ancestor, was nearer to *Alligator* than to *Caiman* and was also nearer the alligator main line than was *Allognathosuchus*. Patterson (1931) somewhat misunderstood me in believing that I did not regard *Allognathosuchus* as closely related to *Alligator*—the intention was only to show it as less close than *Caimanoides*. I agree with him in supposing *Allognathosuchus* a fair structural ancestor of *Alligator*, especially if *Allognathosuchus riggsi* belongs in that genus, which is, however, rather questionable. But the typical species of *Allognathosuchus* were surely aberrant in dentation and accompanying specializations. The better knowledge since given by Mook (1932) of *Alligator prenasalis*, as old as *Caimanoides* or *Allognathosuchus riggsi*, also alters the conception of these phylogenetic details. In any event, all these forms represent more or less diverse but closely related branches of a distinctive alligatoroid group.

²One possible distinction is that in the living forms it is normally the twelfth and in *Eocaiman* the thirteenth lower tooth which is enlarged, but the exact number of teeth is variable, and this slight transposition is not a real obstacle to close relationship.

6. This significantly adds to the evidence for a faunal and geographic connection between North and South America near or somewhat before the beginning of the Tertiary.

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SOME NEOTROPICAL ANTHIDIINAE: *ANTHIDIUM*, *HETER-ANTHIDIUM*, AND *DIANTHIDIUM*

BY HERBERT F. SCHWARZ

The following report is based in part on specimens in the American Museum, in part on material kindly loaned by the British Museum and by the U. S. National Museum.

Professor T. D. A. Cockerell's aid was kindly given in connection with the interpretation of one of the species (see p. 20).

Anthidium artecum Cresson

One female (British Museum) collected at Tepetiapa, Guerrero, Mexico, at an elevation of 3000 feet, by H. H. Smith, in June.

Anthidium chilense Spinola

One female (National Museum) collected at Maipu, Chili, Feb. 2, 1906 (F. V. Ibarro).

Anthidium chubuti Cockerell

One female and one male (British Museum) and one female (American Museum) collected at V. del Lago Xanco, Chubut, Patagonia.

Anthidium deceptum Smith

One male (British Museum) collected at Arequipa, Peru.

Anthidium maculosum Cresson

One female (British Museum) from Mexico.

Anthidium porterae Cockerell

One female (British Museum) and one female (American Museum) collected at Ventanas, Mexico, at an elevation of 2000 feet, by Forrer. (See key supplied in connection with *Anthidium quetzalcoatl*.)

Anthidium 22-punctatum Friese

One female (National Museum) collected at Guayaquil, Ecuador.

Anthidium quetzalcoatl, new species

FEMALE.—Head black with the following maculations: mandibles on their exposed surface except for the multidentate black apical edge; two large subtriangular spots on the clypeus, each almost subequal to the median triangle of black that separates them; the space between the clypeus and the inner orbit of the eyes to the level of the base of the antennae; a spot near the apex of the scape; two somewhat diamond-shaped stripes above the eyes with their pointed inner ends almost uniting. The apex of the clypeus is for the most part narrowly black, shiny, not reflexed, virtually without irregularities in its contour, gradually and very shallowly emarginate along most of its extent, and flanked at each lateral extremity by a brownish semi-transparency. Except for this unpunctate rim, the clypeus is rather coarsely punctured, with narrow, shiny interspaces between the punctures. The front, vertex, sides of face, and cheeks with a dense punctation that gives these areas a rather dull appearance.

The thorax with a similarly dense punctation on the mesonotum, scutellum, and mesopleura. There are heavy, yellow, L-shaped stripes bordering the mesonotum, the shorter arm of the L being along the anterior margin. The axillae and scutellum with a very broad, posterior, yellow border that has a waistlike narrowing at the middle of the scutellum, the scutellum being rather strongly emarginate at this point. The propodeum rather dull, microscopically tessellate over its entire surface, with a superimposed basal band of punctures and a punctated area some distance to each side of the apical part of the enclosure.

The legs black but with a broad, yellow stripe on the external surface of the front and middle tibiae that extends nearly from base to apex and a shorter and more attenuated stripe on the basal half of the external surface of the hind tibiae. The densely pectinate calcaria ferruginous and semitransparent.

The wings with the usual venation of *Anthidium*; hyaline, with a brown streak traversing the upper half of the marginal cell and extending into the apex of the median cell. The nervures deep brown to black.

The abdomen distinguished by a deep, constriction-like depression of the base of tergites 2-5, in addition to the flat depression of the apical region of the tergites beyond the yellow bands. The punctation in the basal region of each tergite sparser than in the equally broad apical region beyond the maculations, but even in this apical region there are interspaces between the sometimes rather chainlike groupings of punctures and the extreme apex of each tergite is smooth. The elevated region between the base and apex, which is occupied by the bands, is for the most part rather sparsely punctured like the base of each tergite. The apex of tergite 6 with a tooth on each side, succeeded by other rather irregular and still smaller denticles that give the border a somewhat rough contour. The band on tergite 1 is divided into four spots,—the outer ones very large, the inner ones smaller and rather cuneiform. The band on tergite 2 has a median interruption that is narrower than the space separating the inner maculations on tergite 1, the two halves of the band gradually narrowing to a point at their inner extremities and being abruptly, narrowly but deeply emarginate above at the middle of each. The two halves of the band on tergite 3 rather similar in shape to the maculations on tergite 2 but barely separated from each other and with the emarginations above lacking except for a slight sinuosity in the contour. The band on tergite 4 like that on tergite 3, but the two halves joined, with merely a

waistlike narrowing to indicate their semidetachment. The band on tergite 5 heavier but not so extensive, being flanked by black on each side, with a V-shaped, emargination above at the middle and with each of its coalescing halves strongly convex above. On tergite 6 there is a large median maculation with insloping sides.

The hair is for the most part silvery, although slightly ochraceous on the vertex and mesonotum. The hairs fringing the apex of the clypeus and the brushes on the under side of the basitarsi are golden. The thick matting of hair on the outside of the basitarsi, the scalelike patches at the apex of the hind tibiae, and the dense ventral scopa are snow-white.

The description is based on a single specimen, in the British Museum, that was obtained at R. Papagaio, State of Guerrero, Mexico, by H. H. Smith. Comparatively few members of the genus *Anthidium*, s. str., have been recorded from Mexico and Central America, for the majority of those described as *Anthidium* belong to other divisions of the Anthidiinae (see Cockerell, 1904, Annals and Mag. Nat. Hist., (7) XIV, p. 206). The following key to the females of *Anthidium*, s. str., from Mexico and Central America, may serve to separate the recorded species (the female of *Anthidium rodriguezi* Cockerell is unknown).

KEY TO FEMALES

- 1—The front with sparse, irregularly grouped, clear punctures scattered over a very finely tessellated surface. Sides of face immaculate but clypeus with two large yellow maculations. Tergites 1-5 of the abdomen each with four maculations of triangular or subtriangular shape
maculosum (= *maculatum* Smith and *americanum* Friese).
 The front very densely and rather coarsely punctured. 2.
- 2.—Tergites 2-5 strongly depressed basally as though constricted, the maculations on these tergites occupying an elevated region between this basal constriction and the flatly depressed apex. The femora black. 3.
- Tergites 2-5 not strongly depressed basally. The middle region of each of these tergites not rising above the base and the apex. At least the middle and hind femora red above apically for a variable extent, usually about two-thirds of their length. 5.
- 3—The margin of the clypeus rather smooth, virtually without irregularities in its contour, slightly emarginate, and not reflexed. *quezalcoatl*, new species.
 The margin of the clypeus very uneven, with several toothlike swellings or prominences; somewhat reflexed. 4.
- 4—Tergite 6 with two large spherical maculations *porterae*.¹
 Tergite 6 with little or no maculation *maculifrons* (= *cognatum* Cresson).
- 5.—A band, briefly interrupted medianly, stretching across the vertex. L-shaped maculations (sometimes interrupted) on the mesonotum. The bands on tergites 2-5 uninterrupted *hallinani*, new species.

¹Different as are *porterae* and *maculifrons* structurally in the male, the females are virtually identical structurally. Differences in the maculations between *porterae* and Atlantic seaboard specimens of *maculifrons* are largely bridged in Mexico and make identification of Mexican specimens of the females of these two species when unaccompanied by the males rather difficult. See Schwarz, 1928, Journal of N. Y. Entomological Society, XXXVI, pp 389-372.

A spot behind the summit of each eye. A faint stripe on each side of the mesonotum above the tegulae. The bands on at least tergites 2 and 3 interrupted. *aztecum*.

***Anthidium hallinani*, new species**

MALE.—Black with yellow and a few rust-red maculations. Head black with the following parts light yellow: mandibles except the three black teeth at the apex, of which the outermost and largest is suffused with red at its base; the clypeus, except for a broad triangle of black at the base and a narrow line of black or transparent red along the apex, which is straight, not excavated or depressed, along the middle; a maculation on each side of the face, filling the space between the clypeus and the eye and terminated at the level of the base of the antennae; a narrow line, very briefly interrupted in the middle, extending behind the ocelli from the summit of one of the compound eyes to the summit of the other; the scape except for a black, longitudinal line posteriorly (in one of the paratypes the yellow is suffused with ferruginous). The flagellum dark above, more or less ferruginous below, segments 3 and 4 being more extensively and conspicuously red than the other joints. The punctation, concealed or almost concealed on the front by the heavy growth of pale hair, is fine and dense on the vertex, coarser and with interspaces on the clypeus.

The mesonotum finely and densely punctate, the punctures on the scutellum barely if at all larger than those on the mesonotum, and the punctures on the mesopleura only a little larger. The propodeum tessellate-punctate along its base and sides, merely tessellate in the lower half of the enclosure. The tubercles with only a very feeble carina transversely across their summit,—in some instances even absent. The tegulae with rather fine but fairly dense punctures that are more distinct on the elevated middle portion than on the periphery. The following parts are light lemon-yellow: an L-shaped figure bordering each side of the mesonotum, the shorter arm of the L extending about one-third of the distance across the anterior margin of the mesonotum, the longer arm along the side of the mesonotum to connect with the broader band on the axillae and posterior rim of the scutellum, at the middle of which the band has a waistlike narrowing, the tubercles above and especially on their outer half, and sometimes the otherwise red tegulae in front (one of the paratypes). The summit of the tegulae a little darker red than the periphery.

The legs have the following red maculations. the apical half of the front femora within anteriorly and the apex of the front femora briefly above, the front tibiae within anteriorly, the tarsal joints beyond the front basitarsus; the middle coxae and trochanters sometimes with faint traces of red, the middle femora extensively red, especially the upper surface of these femora, where the maculation spreads broadly from the apex almost to the base of the joint, the middle tibiae within anteriorly, and the tarsal joints beyond the middle basitarsus; the hind coxae and trochanters sometimes with faint traces, the hind femora extensively red, especially on the upper surface of these femora, where, as in the middle femora, the maculation extends from the apex almost to the base of the joint, the hind tibiae sometimes with a faint suffusion of red within posteriorly, especially at the base, the tarsal joints beyond the hind basitarsus. The legs have the following yellow maculations: stripes posteriorly on the front and middle femora extending from the apex two-thirds or three-quarters of the way to the base; the outer surface of the front and middle tibiae except for a narrow rim of black posteriorly; the outer surface of the hind tibiae except for a

broad area of black anteriorly and sometimes a narrow edging of black posteriorly; the calcaria; the basitarsi of all the legs on their outer surface. The other parts are black, including the apical half of the tarsal claws.

Wings hyaline; nervures deep brown to blackish; a longitudinal streak (due to the density of the microscopic hairs) occupying the upper half of the marginal cell, and a much more vague and less pronounced deepening of tint at the apex of the median cell. Venation that of *Anthidium*.

Tergite 1 quadrimaculate, the outer maculations large and suboval, the inner ones relatively small and sublunar; the bands on tergites 2-5 uninterrupted but with a more or less waistlike contraction at their middle, that on tergite 2 being, in addition, slightly emarginate on each side below (and sometimes also on the corresponding point above) and those on tergites 4-5 and sometimes also that on tergite 3 being slightly emarginate on each side above. Tergite 6 has a large median maculation that occupies a little more than a third of the width of the tergite; above, this maculation is more or less emarginate at the middle, and below it has a very obtuse, inverted V-shape, corresponding with the boundary of the raised portion of the tergite. Tergite 7 varying from mostly black with little rust-red to almost wholly rust-red. The basal concavity smooth except for usually a few punctures near the edge and separated from the dorsal part of the first segment by a carina. The tergites punctate-tessellate, very densely and rather uniformly punctated in the region below each of the bands except for a very narrow, impunctate apical edging; in the region above the bands the punctuation is sparser, especially so in the middle of this region, and the punctures are frequently of rather irregular size although on the whole rather fine. In contrast, the dark sides of tergite 6 are, like most of tergite 7, coarsely and rugosely punctured. The lateral teeth, one on each side of tergite 6, are straight and acute, and are variably black, red, or black with red tip. The pygidium terminates in a stout, blunt, smooth, median spine that is rounded above toward its apex; to each side of this spine, and narrowly separated from it is a broad, short lobe, rounded on its outer side, and slightly rounded to angulate on its inner side, but truncate on its apical edge. These lateral lobes, although on a lower plane than the central spine, extend no farther rearward than the spine itself. The last visible sternite ferruginous, with a strong, black-tipped spine at each of its lateral extremities, and an extensive, slightly swollen, impunctate area in the middle.

The hairs for the most part silvery to white, as well as ochraceous to golden. Silvery to white are the hairs of the clypeus and front, the dense lateral fringes of the scape, the hairs of the sides of the thorax, and those of the under surface of the thorax and of the venter, the hairs on the under side of the front femora, the fringes posteriorly on the front and middle tibiae and tarsi and anteriorly on the hind tibiae and hind basitarsi, the short, feathery hairs on the outer surface of the hind tibiae, which are for the most part scattered but at the apex of the joint are massed posteriorly in a dense, white patch. The hairs on the red areas of the femora seem, according to the angle at which the insect is held, now red, now gray. The hairs of the under side of the front tibiae are of a reddish gold, and golden, too, are the hairs of the under side of the tarsal joints. The hairs on the vertex and on the tergites are in the main ochraceous to golden and those on the mesonotum and scutellum are inclined also, although a little less emphatically, to assume an ochraceous hue.

Length, 10 to 11 mm.; width of thorax, $4\frac{1}{4}$ to $4\frac{3}{4}$ mm.; length of forewing, including tegula, $8\frac{1}{4}$ to $8\frac{1}{2}$ mm.

FEMALE.—Similar to the male but with the following differences: mandibles multidentate as in other females of *Anthidium*. The apical margin of the clypeus slightly upthrust and faintly emarginate along the middle with two blunt, low teeth on each side of this central, toothless area; this apical margin is for the most part black and shiny. The clypeus with the black basal triangle far more extensive, its apex attaining the apex of the clypeus and dividing the yellow maculation into two large, subtriangular spots. The yellow maculation on the front of the scape terminates before the base (in the female paratype confined to a spot at the apex).

In the allotype the maculations of the thorax correspond with those of the male; in the female paratype the L-shaped bands are broken into a stripe along the side of the mesonotum and another independent stripe part way along the anterior border of the mesonotum.

The yellow stripes posteriorly on the front and middle femora confined to the apical half of the joint. The yellow stripes on the external surface of the tibiae are terminated a short distance before the apex of the joint and are narrower than in the male. The basitarsi dark but completely concealed under a thick matting of snow-white hair that is in sharp contrast to the reddish golden brushes on the under side of the joint. Only the anterior fringe on the hind tibiae comparable with the fringe in the male, the posterior fringes on the fore and middle tibiae being inconspicuous.

The inner elements of the band on tergite 1 completely, or nearly, united with the outer elements. Tergite 6 with an inconspicuous, blunt tooth on each side and without a depressed apical rim as in the male; the maculation on this tergite is centrally placed, slightly emarginate basally at its middle and convexly rounded to each side of this emargination, with its apex narrower than its base and straight, not obtusely V-shaped as it is in the male. The ventral scopa is silvery white except for a few golden to brownish hairs toward the apex of the last visible sternite.

Length, 9 mm; width of thorax, 4 mm.; length of forewing, including tegula, 7½ mm.

The description is based on two males and one female collected by T. Hallinan, Jan. 1, 1915, along the Culebra-Arrijan Trail, Canal Zone, on a single male collected by C. H. Curran, Feb. 4, 1929, at Corozal, Canal Zone, and on a single female obtained by Champion, at S. Geronimo, Guatemala. The holotype, allotype, and the two male paratypes are in the American Museum. The female paratype from Guatemala is in the British Museum.

This species, in the female at least, is not very far separated from Cresson's holotype of *aztecum*, the maculations of which are, however, more restricted (see key). In *aztecum* the region of the clypeus between the two lateral maculations is impunctate (punctate in *hallinani*) and the apical rim of the clypeus is truncate and toothless (slightly undulating and with two blunt teeth on each side in *hallinani*).

The contrast, however, is greater in the males. The male allotype of *A. aztecum* resembles structurally *A. maculifrons* Smith (= *A. cognatum* Cresson) and is wholly different structurally from the male of *hallinani*.

Almost certainly, I think, the male allotype of *aztecum* is incorrectly associated with the female holotype. I regard this allotype as a not very clearly separated variety of *maculifrons*, a species which is represented not only on the South Atlantic seaboard but in certain of our Western states and in Mexico (Schwarz, 1928, Journal of N. Y. Entom. Soc., XXXVI, pp. 369-372).

Anthidium hallinani is similar to *Anthidium sanguinicaudum* but is differentiated structurally in the male by the truncate apex of the lateral lobes of the pygidium and the absence of a small, downward-directed tooth at the apical extremity of the last visible sternite; and in the female by the presence of merely a small, blunt tooth on each side of tergite 6 in contrast to the sharp spine of *sanguinicaudum*. In the male of *hallinani* the apical part of the femora (particularly so in the case of the third femora) is extensively red, whereas in the males of *sanguinicaudum* these red areas are replaced by black. The female of *hallinani* has, like its male, tricolored legs with black rather predominant over either red or yellow; in contrast, the female of *sanguinicaudum* has legs that are almost wholly ferruginous variegated extensively with yellow. The male of *hallinani* has a sharply demarked, median maculation on tergite 6; the male of *sanguinicaudum* a continuous band on this tergite. Tergite 6 of the female of *hallinani* is black with a large yellow maculation; in *sanguinicaudum* females tergite 6 is almost wholly yellow.

Some of the differences between the female of *A. variegatipes* Cockerell from Bolivia (1927, Proc. U. S. Nat. Mus., LXXI, Art. 12, pp. 1-2) and *A. hallinani* are as follows:

Short lateral face marks, not reaching level of antennae. Margin of clypeus broadly yellow, semicircularly emarginate by black above. Short line at base of tibiae, supplemented on middle and hind pair by another line farther down. Middle femora red with two black stripes. Middle of scutellum with shining surface showing between the punctures. Tegulae black, with two pale yellow spots. The band on tergite 2 medianly interrupted. Tergite 6 with two large transverse patches. Venter of abdomen largely red. *variegatipes*.
 Face marks reaching base of antennae. Clypeus bimaculate. The stripes on the tibiae running from the base nearly to the apex. Middle femora with basal one-third above and basal two-thirds below black, with apical two-thirds above and apical one-third below red, and with a yellow stripe posteriorly on the apical half. Middle of scutellum without a shining surface showing between the punctures. Tegulae red. Band on tergite 2, like those on 3-5, medianly uninterrupted. Tergite 6 with a large maculation that occupies most of the tergite. First sternite of abdomen with more or less red; remaining sternites largely or wholly black. *hallinani*.

The male of *variegatipes* has not yet been recorded.

Anthidium sanguinicaudum, new species

MALE—Black, with for the most part yellow, and some rust-red maculations. The head densely, finely, and rather evenly punctured, with a faint, median, longitudinal carina down the basal half of the clypeus. The apex of the clypeus straight, not emarginate or dimpled at the middle, with semitransparent, brownish border that is thickened at each lateral extremity. The mandibles tridentate, the outermost tooth longer but not broader than the two inner ones. The following maculations light lemon-yellow: mandibles except teeth and basal prominences, entire clypeus except narrow, hyaline, apical edge, the space between the clypeus and the inner orbits of the eyes to the level of the base of the antennae, a narrow line above each of the eyes (more extensive in the paratype from Venezuela, the stripes almost uniting), the scape except for a black line posteriorly, and a spot on the third joint of the antennae of the paratype. The fourth and fifth joints of the antennae are red in front in the paratype.

The mesonotum with dense, fine, almost granular punctation like that of the head; the mesopleura and scutellum with the punctures barely larger and almost as dense. The propodeum tessellate-punctate along its base and sides, merely tessellate in the apical half of the enclosure. The tegulae with small, dense punctures that are readily traceable on the reddish black to reddish middle, but are inconspicuous on the surrounding yellow. The tubercles erect and carinate along the top. The following maculations light lemon-yellow: an L-shaped figure bordering each side of the mesonotum, the shorter arm of the L extending about one-third of the distance across the anterior margin of the mesonotum, the longer arm along the side of the mesonotum to connect with the continuous band on the axillae and posterior rim of the scutellum, at the middle of which the band has a waistlike narrowing; the tubercles; the tegulae except for the center.

The legs have the following yellow maculations: a stripe on the apical half of the middle femora (and in the paratype also on the apical half of the front femora); the entire exterior surface of the front and middle tibiae; and the entire exterior surface of the hind tibiae except for a large, dark emargination anteriorly; the calcaria; all of the basitarsi (the remaining tarsal joints mostly reddish).

Wings hyaline; nervures deep brownish to blackish; a faint, longitudinal streak (due to the density of the microscopic hairs) occupying the upper half of the marginal cell, and a brownish stain briefly at the apex of the median cell. Venation that of *Anthidium*.

Tergite 1 of the abdomen with a medianly divided yellow band the halves of which are in turn narrowly subdivided (doubtless in some cases entire except for a posterior emargination); tergite 2 similarly four-spotted but with the interruptions so narrow that the least spread of the maculations would result in a complete band deeply but briefly emarginate on each side anteriorly, which is actually the case in the paratype; tergites 3–6 with rather wide, entire bands that have a waistlike contraction at the middle. In the type the bands on tergites 3–4 have at most a very gentle, scarcely noticeable, sinuous emargination above at each side, while the paratype has the band on tergite 3 emarginate deeply but briefly on each side anteriorly. Tergite 7 transparent rust-red except for cloudiness near the base (in the paratype the mainly red pygidium has faint yellow maculations on the lateral lobes and fragments of yellow maculations here and there at the base); the last visible sternite also rust-red; the tips of the sharp, straight, lateral spines on tergite 6 also red and transparent. In the

paratype the area below the yellow band on tergite 6 is likewise rust-red. The abdomen for the most part very finely punctured, the punctures being denser in the area below the yellow bands than in the area above the yellow bands on tergites 1-4, almost of equal density in these areas on tergite 5, and if anything rather denser basally than apically on tergite 6 (especially is this true of the type). A narrow edging along the apex of the rims of these tergites is impunctate. The punctures at the base of tergite 7 relatively coarse. The lateral lobes of tergite 7 extend only a little beyond the central spine, which is of evenly rounded contour above and slightly down-pointing, and are each much broader than the space that separates each of them from the central spine. They are not truncate along their lower edge but irregularly rounded to very obtusely angulate. The apical sternite has two intersecting carinae that form an irregular cross. At each of the lateral extremities of the transverse carina is an outward- to slightly down-pointing, strong tooth; a much smaller down-pointing tooth is at the apical extremity of the longitudinal carina, forming the tip of the broadly rounded apex of the last visible sternite.

The hair for the most part silvery to white, being silvery on the clypeus, the front, the cheeks, the dense lateral fringes on the scape, the sides of the thorax, the thorax beneath and abdomen beneath. The fringes posteriorly on the fore and middle tibiae and basitarsi and those anteriorly on the hind tibiae and basitarsi are almost white, and the matted, plumose hairs posteriorly along the apical half of the third tibiae are wholly so. Ochraceous to golden are the hairs fringing the apex of the clypeus, those on the vertex, and those on the under side of the tarsal joints, as well as those on the tergites. The hairs of the mesonotum only slightly ochraceous,—probably a variable condition depending somewhat on whether the specimen is a freshly emerged one or not.

Length, 11 mm.; width of thorax, 4 mm.; length of forewing, including tegula, $8\frac{1}{4}$ mm.

FEMALE.—Similar to the male but with the following differences: mandibles multidentate as in other females of *Anthidium*, *s. str.* The apical margin of the clypeus slightly upthrust, and faintly emarginate along the middle, with two blunt, low teeth on each side of this central toothless area; this apical margin is black and shiny, not transparent. The clypeus not wholly maculated, but with a large triangle of black, dilated at the base, thrust downward toward the apex and, in the allotype at least, separating the yellow maculation into two large yellow spots. The scape of not so pure a yellow, tintured with ferruginous and blackened briefly at its base and apex, and segments 4 and 5 of the antennae red below and to some extent also above.

The tegulae red, maculated with yellow only anteriorly.

Except for the partly black, partly red coxae (the anterior pair wholly black in the paratype), a black spot anteriorly near the apex of the hind tibiae, and black cloudiness here and there in the red areas, the legs are almost wholly ferruginous or rust-red variegated with yellow. The yellow areas include a stripe on the apical half of the under side of the front and middle femora, the entire external surface of the tibiae except for a small, semitransparent, red spot at the apex of the fore and middle tibiae and a more extensive area of red and black anteriorly on the apical two-thirds of the hind tibiae.

Two large, posteriorly not emarginate, cuneiform maculations on tergite 1, that are pointed toward each other and only very briefly separated. Two similar but a little more attenuated stripes on tergite 2 that are almost united at the middle into a

continuous band. Tergites 3-5 banded as in the male except that the median, waist-like narrowing is emphatic only on the band of tergite 3, and the bands are virtually entire laterally, not with a sinuous emargination above. Tergite 6 wholly yellow except for a small, faint, black spot on each side near the base and a darkened to reddish, brief, apical rim. A red spot occurs on each side of tergite 1 just above the yellow maculations and extends over to sternite 1. The venter otherwise rather dark. On each side of tergite 6 there is a sharp, conspicuous tooth.

The hair as described for the male except that instead of basitarsal fringes, all of the basitarsi of the female are covered concealingly with exceedingly dense, snow-white hair that is in sharp contrast with the reddish golden to fox-red tarsal brushes, and except that the fringes posteriorly on the front and middle tibiae are very much reduced.

Length, 8 mm.; width of thorax, $3\frac{3}{4}$ mm.; length of forewing, including tegula, $7\frac{1}{2}$ mm.

The description of the male is based on a specimen (British Museum) that was donated by Dr. G. Salt. It was collected at Mamatoco, Santa Marta, Colombia, at an elevation of 500 feet, Feb. 18, 1927, by "M.A.C." It was taken in copula with the allotype (likewise in the British Museum). A female paratype (American Museum) was collected at Rio Frio, Magdalena, Colombia, on Feb. 1, 1927, by Dr. G. Salt. A male paratype (U. S. National Museum) was collected at C. Bolivar, Venezuela, on *Convolvulus*, by M. A. Carriker.

In some ways the Venezuelan specimen differs slightly from the specimens from Colombia but, in the absence of a series from Venezuela, it seems wiser not to give recognition to what may represent merely an individual variation. It is rather curious that, so far as I have been able to ascertain, there is only one other reference in the literature to a Venezuelan species, namely that described by Pérez (1892, *Annales de la Société Entomologique de France*, LXI, pp. 55-56) as *Anthidium Buyssoni*. The description suggests a *Hypanthidium* rather than an *Anthidium*, *s. str.*

Differences between *Anthidium sanguinicaudum* and *Anthidium hallinani* are discussed under the latter insect. Both of these species are characterized in both sexes by continuous bands on several of the abdominal tergites,—a form of maculation more often associated with *Heteranthidium* than it is with *Anthidium*.

Heteranthidium atoyacae, new species

FEMALE.—The head black with pale yellow maculations as follows: spot on each side of the clypeus, a supraclypeal triangle, lateral face marks (broad below, tapering above into a narrow rim along the inner orbits and terminating at the level of the anterior ocellus), and a brief line on the outer side of each eye near its summit. The mandibles black, short and rather thick, apparently toothless along their apical

margin, with two carinae near the outer margin, of which the inner carina is the stronger and more continuous; the mandibles somewhat rugose on the broad surface inward of these ridges. The clypeus rather coarsely punctured, somewhat shiny, its apical margin with a feeble tooth to each side of the very shallowly emarginate middle; the front and vertex much more delicately but very densely punctured, wholly opaque. The antennae very short, the flagellum only about twice as long as the scape, when the antennae are backward directed, their tip extends only just beyond the occiput. The hair silvery gray, rather evenly distributed, longest on the cheeks below.

The thorax black with the following cream-colored maculations. a line on each side of the anterior border of the mesonotum, a line along each of the lateral borders of the mesonotum extending to the axillae, a spot on each of the axillae and two more or less disintegrated spots posteriorly on the scutellum, a suboval maculation on each mesopleuron just below the tubercles, and a small spot anteriorly on the tegulae supplemented by a still smaller, dull red spot laterally. The thorax as densely punctured as the front, but the punctures larger and coarser on the mesonotum, scutellum, and mesopleura. The triangular enclosure of the propodeum covered with rather clear, strong punctures on a more or less tessellate surface, only the extreme apex of the enclosure being punctureless and exclusively tessellate. The sides of the propodeum beyond the enclosure with for the most part small, rather clear punctures on a more or less tessellate surface. The tubercles erect, sharply carinate above and shiny, their posterior aspect concave. The tegulae shiny, with for the most part clearly separated punctures. The hair silvery gray like that of the head, being longest on the pleura and sides of the propodeum.

The wings subhyaline, a little darker in the upper half of the marginal cell and in that portion of the apex beyond the cells. The venation fuscous except the costal vein, which inclines to ferruginous. The second transverse cubital vein completely interstitial with the second recurrent vein.

The legs are tricolored, with ferruginous and black predominant over yellow. Ferruginous are the following parts: forelegs with the trochanters narrowly at the apex, femora above especially toward the apex, anterior part of the tibiae; middle legs slightly toward the apex of the trochanters, femora entirely except for a basal spot of black below, tibiae entirely except for a narrow rim of black posteriorly on the external side, all the tarsal joints except for the darkened apical half of the claws; hind legs with the femora wholly except for a black streak anteriorly at the base, tibiae except for a black spot occupying the basal two-thirds of their external surface along the anterior half and a darkened basal area on the under side of the joint, the tibial spines, merely a narrow anterior rim on the basitarsi, and the remaining tarsal joints except for the darkened apical half of the claws. The other parts of the legs are black except that at the base of the tibiae of all of the legs there is a distinct, pale yellow maculation. The legs are robust, covered with silvery gray to whitish hairs that are rather long on the under side of the femora, especially in the case of the front pair, but short, rather appressed, and scalelike on the outer surface of all the tibiae. The basitarsi flattened, those of the hind pair of legs broad; the tarsal brushes pale gold. The pulvilli rather small.

The first five tergites of the abdomen relatively shiny even though they are fairly closely punctured, the punctures being very fine at the base but somewhat larger toward the apex of each tergite. The sixth tergite dull and granular, although finely

so. The abdomen black with uninterrupted, pale yellow bands on the first five tergites. These bands are rather abruptly broadened at their lateral extremities, but narrow and of an irregularly undulating character above over most of their extent, being very obtusely V-shaped at their middle. The band on tergite 5 is more uniformly broad than are the bands on tergites 1-4. There is a small spot placed at the middle of each lateral half of tergite 6. The hairs are pale and long on each side of the basal concavity of tergite 1, sparse and short but erect on tergites 2-5, while tergite 6 is rather densely covered, especially toward its apex, by short, appressed silvery hairs. The ventral scopa is silvery white.

Length, $9\frac{1}{2}$ mm.; width of thorax, $3\frac{3}{4}$ mm.; length of forewing, including tegula, $8\frac{1}{2}$ mm.

This species, which is described from a single specimen in the British Museum that was collected by Schumann at Atoyac, Vera Cruz, Mexico, is one of the smaller members of the genus *Heteranthidium*. In my key to the genus (1926, Amer. Museum Novitates, No. 218, pp. 2-4) it comes closest to *Heteranthidium crassipes* and *Heteranthidium fontemvitae*, both from Florida.

In size, *atoyacae* is comparable especially with *crassipes*. In both *atoyacae* and *crassipes* the mandibles are short. In *crassipes* the two teeth, one to each side of the middle of the apex of the clypeus, are much stronger than in *atoyacae*. In both these species the antennae are short but in *atoyacae* the terminal joint of the flagellum is only about one and one-fourth times as long as it is wide whereas in *crassipes* the proportions are nearly as two is to one. The punctation of *atoyacae* is much less coarse than is that of *crassipes*, the punctures of which are large and relatively sparse, with shining interspaces on mesonotum and abdominal tergites, whereas *atoyacae* is dull on the mesonotum and with a somewhat subdued sheen on the abdominal tergites. The facial and thoracic maculations of *atoyacae* are cream-colored and more restricted than are the deep yellow maculations of *crassipes*. The clypeus of *atoyacae* is bimaculate; that of *crassipes* largely yellow. On the mesonotum the stripes are interrupted at the anterolateral angles in *atoyacae* whereas in *crassipes* they are L-shaped. There are four widely separated maculations on the scutellum and axillae of *atoyacae*, in contrast to the broad, continuous maculation, briefly interrupted at the middle of the scutellum, that is present in this region in *crassipes*. The carinate tubercles are immaculate in *atoyacae*, maculated in *crassipes*. The anteriorly undulating bands on the tergites of *atoyacae* are replaced in *crassipes* by bands that are rather evenly emarginate above, suggesting a very gradual, uninterrupted curve that terminates somewhat before the broad lateral extremities of the bands. In both species tergite 6 is two-spotted. The

legs of *atoyacae* show a far greater predominance of red over yellow, only the bases of the tibiae being spotted with yellow, whereas in *crassipes* virtually the entire external surface of the front and middle tibiae, a large area on the hind tibiae, and a stripe on the under side of the front femora are yellow.

From *fontemvittae* the present species differs structurally in having short, broad mandibles with a rather straight apical edge, not long, greatly overlapping mandibles with a rather inslanting apical edge. The antennae are much shorter than those of *fontemvittae*, all of the segments except 1, 2, 3, and 12 being shorter than broad whereas in *fontemvittae* only segments 4, 5, and 6 are shorter than broad. The tubercles are sharply carinate above in *atoyacae*, less sharply so in *fontemvittae*; the depressed apical rims just beyond the bands on the tergites are narrow and, except at their extreme base, impunctate and shiny in *atoyacae* whereas in *fontemvittae* these rims are rather more developed and very densely and strongly punctured. Other differences, fundamental as well as superficial, could be added.

Dianthidium bertonii Schrottkey

Dianthidium bertonii SCHROTTKEY, 1905, *Anales Cientificos Paraguayos*, (1), No. 4, pp. 6, 12; 1908, *Anales de la Sociedad Cientifica Argentina*, LXV, pp. 230-231.

Two specimens, a male and a female (U. S. National Museum) were collected by K. Fiebrig at San Bernardino, Paraguay, the female on Nov. 2, the male on Nov. 29, "on a thin green leafless stem of a labiate."

This species has the typical scalelike tegulae of the North American *Dianthidium* although lacking a coxal spine. Its second submarginal cell is slightly larger than the first and its second recurrent vein extends beyond the second transverse cubital by a distance only about half that by which the first recurrent vein extends beyond the first transverse cubital.

Dianthidium currani, new species

MALE—Very small and highly maculated species, black with rich yellow and ferruginous markings. The head has the following parts yellow: mandibles except the three black apical teeth, clypeus, inner orbits of the eyes (to the level of the anterior ocellus in the Barro Colorado specimens, confluent with the postorbital band in the specimens from Rio Frio), a continuous broad band encircling the back of the head from the base of one mandible, along the posterior orbit of the eye, across the vertex to the base of the other mandible, the supraclypeal area to above the level of the base of the antennal sockets (this maculation usually forks above in the case of the Barro Colorado specimens but is at most slightly emarginate above in the case of the Rio Frio specimens), a longitudinal yellow stripe below the middle ocellus (absent in

several of the Barro Colorado specimens), and a yellow stripe (sometimes indistinct) anteriorly on the scape, which is otherwise ferruginous as are the joints of the flagellum. The head densely punctured.

The yellow maculations of the thorax are as follows: a spot on each side of the pronotum, L-shaped maculations bordering the mesonotum, the longer arm of the L being along the side and confluent with the continuous yellow of the axillae and scutellum, tubercles, a curved stripe anteriorly or, more rarely, an encircling line on the otherwise ferruginous tegulae, virtually the entire mesopleura. The mesopleura and mesonotum with dense punctures, those at the very base of the black area between the short arms of the L-shaped figures being especially small and fine. The posterior face of the metathorax densely, uniformly, and microscopically tessellate and, in addition, with distinct punctures grouped fairly densely at the base and sides but absent from the middle region. The extreme base of the propodeum with a narrow row, medianly discontinuous, of shallow and rather indistinct pits.

The legs almost wholly yellow, variegated with ferruginous usually on the femora above, the tibiae within, and the tarsal joints beyond the basitarsi. In the Barro Colorado specimens the trochanters are conspicuously marked with black, and in addition there are sometimes one or two splashes of black at the base of the femora; in the specimens from Rio Frio these dark markings show only faintly or not at all. The pulvilli rather elongate, not so long, however, even in extreme cases, as the tarsal claws, which on their apical half are dark red to black.

The wings with the second recurrent vein extending a considerable distance beyond the second transverse cubital vein, about as far as the first recurrent vein extends beyond the first transverse cubital vein. The first and second transverse cubital veins convergent above, the first straight, the second with a slight sinuation, less marked than in the second recurrent vein. The marginal cell has a short appendix at its lower apical extremity. The wings somewhat deeper than hyaline and darkened in the marginal cell and in the veinless apical part adjacent to the marginal cell. The venation brownish but the stigma rather more inclined to dull ferruginous.

The abdomen less closely and more finely punctured than the head and thorax, with the larger punctures near the base of each tergite, the smaller ones near the apex, but the rims narrowly impunctate at the apex. The tergites reddish, with broad, uninterrupted bands across the upper half of tergites 1-3, still broader, uninterrupted bands on tergites 4-5, and with tergites 6-7 wholly yellow as is the venter. The concavity at the base of tergite 1 usually rimmed irregularly and discontinuously with black. At the middle of the apex of tergite 6 there is a prominence or tubercle that is slightly cylindrical viewed from above and truncate and subtriangular viewed from below. The seventh tergite has a wide, rather shallow, subrectangular emargination along its middle, resulting in two widely separated, strong, narrow, lateral spines.

The hair light, nowhere very dense or conspicuously long, rather evenly distributed over the head, thorax, legs, and abdomen, that on the clypeus, vertex, mesonotum, and inner surface of the basitarsi tending to golden, that on the under surfaces of the body silvery.

Length, $4\frac{1}{2}$ to 5 mm.; length of forewing, about 5 mm.

FEMALE.—Little differentiated from the male in its maculations, sculpturing, and color and character of hair. The mandibles four-toothed instead of three-toothed and more extensively black at the apex. The yellow maculation in the supraclypeal

area sometimes more or less disintegrated but in one specimen at least even more replete than in the Barro Colorado males. The yellow bands on tergites 4-5 rather narrower than in the male, and tergite 6 usually more or less ferruginous apically instead of wholly yellow. The venter predominantly ferruginous and its scopa silvery. Tergite 6 without armature, resembling the preceding tergites. The pulvilli much less developed than in the male.

Length, $4\frac{1}{2}$ to 5 mm ; length of forewing, about 5 mm.

It may be that *curranii* is structurally close to if not identical with what Schrottky has described as *iheringi*. Nevertheless, in Schrottky's description no mention is made of the character, so conspicuous in the male of *curranii*, that occurs on tergite 6, and the lateral spines on tergite 7 of *iheringi* are said to be tiny, not well developed as in *curranii*. In fact, the description of *iheringi* in this respect as well as in its allusion to coarse punctation is more suggestive of Cockerell's *gualanense* than it is of *curranii*. The specimens of *curranii* are even smaller than *iheringi*, ranging from $4\frac{1}{2}$ to 5 mm. as against $6\frac{1}{2}$ mm. specified for *iheringi*. The maculations of *curranii* do not entirely accord with those described for *iheringi*. The antennae are wholly ferruginous, with a yellow stripe on the scape, whereas those of *iheringi* are described as "rust brown at the base" with the implication that beyond the base the antennae are black. In *curranii* virtually all of the mesopleuron is yellow, in *iheringi* only a small spot anteriorly. In *curranii* both the axillae and scutellum are virtually all yellow, forming a continuous band with the L-shaped yellow borders of the mesonotum; in *iheringi* there are, instead, two maculations at the tip of the scutellum. In the specimens of *curranii* before me there are lacking the median longitudinal stripes on the thorax indicated for *iheringi*. Finally *curranii* has the yellow band on tergite 1 continuous, not interrupted as in *iheringi*.

In its maculations *Dianthidium curranii*, male, is very like *Dianthidium gregarium* subspecies *colombiae*, male, which likewise occurs at Rio Frio, Colombia. The black apical joint of the flagellum of *D. gregarium* subspecies *colombiae* and the presence of black on many of the other joints serve to differentiate this insect from *curranii*, while the absence of yellow from the mesopleura of *colombiae*, male, if constant, is an even more striking superficial difference. The notably longer, black-tipped, lateral spines on tergite 7 of *gregarium* subspecies *colombiae* best differentiate it, however, from *curranii* with its much shorter and wholly yellow spines. There is also a strong superficial resemblance between both sexes of *curranii* and *Hypanthidium panamense*.

One of the males from Barro Colorado Island, Canal Zone, collected by C. H. Curran, Dec. 23, 1928, has been designated the type. This

specimen and thirteen male paratypes from the same locality, collected by C. H. Curran, E. I. Huntington, and H. F. Schwarz, are in the American Museum. The specimens collected by Huntington and Schwarz were obtained March 22-24, 1933. Two male paratypes from Rio Frio, Colombia, collected Jan. 1, 1927, by G. Salt, are in the British Museum, the third paratype from that locality is in the American Museum. The allotype, collected by H. F. Schwarz, March 23, 1933, at Barro Colorado Island, and four female paratypes from the same locality, collected by E. I. Huntington and H. F. Schwarz, March 22-24, 1933, are in the American Museum.

Dianthidium gregarium (Schrodtky)

Hypanthidium gregarium SCHRODTKY, 1905, *Anales Cientificos Paraguayos*, (1), No 4, pp. 8-10, 12.

Anthidium gregarium, FRIESE, 1908, 'Die Apidae (Blumenwespen) von Argentina,' pp. 69-70. STRAND, 1910, *Zool. Jahrb. Syst. Geogr. und Biol.*, XXIX, p. 548.

Dianthidium gregarium, COCKERELL, 1912, *Psyche*, No. 2, p. 45; 1914, *Proc. U. S. Nat. Mus.*, XLVII, p. 93.

A female (U. S. National Museum) collected by W. T. Foster, Sapucay, Paraguay, in February. It differs from Schrodtky's description of the typical form only in that the mandible is quadridentate, the two inner teeth (possibly concealed in Schrodtky's specimen) being the smaller ones, and in that the femora (especially those of the hind pair of legs) are more or less black.

A male specimen (American Museum) from Villa Rica, Paraguay, 1900.

Dianthidium gregarium colombiae, new species

MALE.—Differs from the typical subspecies in the greater prevalence of ferruginous and yellow and the corresponding subordination of black. The area between the yellow antennal carinae is red, not black. There is a ferruginous patch, too, on each side of the pronotum. Except for a little black on the coxae and except for the reddish black apical half of the tarsal claws, all of the joints of the leg are ferruginous variegated with yellow, the yellow being most conspicuous on the front and hind coxae, on the femora beneath, on the external surface of the tibiae (especially the front and middle pair) and on the external surface of the basitarsi and adjacent tarsal joint. Not merely the apical rims but the bases (for the most part) of the tergites are ferruginous—indeed the only evidence of black on the abdomen, either dorsally or ventrally, is the dark basal concavity on segment 1, the basal region of tergite 2, and the black tips of the two long, yellow, lateral spines on tergite 7. The yellow bands on the tergites are exceedingly broad and uninterrupted, occupying most of the exposed surface. On tergites 1-2 the bands are somewhat suffused with ferruginous along their middle; those on the subsequent tergites are clear yellow and of increasing breadth.

FEMALE.—What I believe to be the associated female of the above-described male is structurally like the male in having small carinae converging below between the antennae, down-sloping tubercles that are rather flattened above although not scalelike as in typical *Dianthidium*, a medianly discontinuous row of narrow and inconspicuous pits at the base of the propodeum, a rather short and apically broad scutellum emarginate medianly, and forewings of identical venation to those of the male and with their upper margin notably darker than the rest of the wing.

The female is even more extensively maculated than the male, and shows a greater inclination to reddish suffusion of the yellow maculations, particularly in the case of the head and abdomen. The paratype is especially reddened but at least part of this intensification of its coloration may be due to cyanide staining. The black area on the head, viewed from in front, has shrunk in the case of the allotype to a broad horseshoe-shaped figure that rings the ocelli; from the outer edge of each of the down-pointing arms of the horseshoe a narrow streak of black descends to the base of the antennae. In the even more completely maculated paratype only the vestiges of this black figure remain. The full maculation of the cheeks corresponds with the condition in the female of subspecies *minor* (in typical *gregarium* and in the subspecies *clypeata* the maculation on the cheeks terminates midway down the posterior margin of the eyes). The band along the inner margin of the eye is, as in typical *gregarium*, confluent with the band along the vertex, not terminated, as in subspecies *continuu-fasciatum*, a little above the base of the antennae. The clypeus of *colombiae* is wholly maculated, not black as in the typical subspecies, nor with a transverse ferruginous line in the middle as in subspecies *clypeata* and *minor*. There is a small, subdued red maculation at the top of the mesopleura just below the tubercles. The legs have more black on the coxae and trochanters than is the case in the associated male and the yellow areas on the femora and tibiae are not sharply differentiated from the ferruginous, being indistinguishable in the paratype. The abdomen in both the female allotype and the female paratype is without a trace of black. In contrast to typical *gregarium* and its other subspecies, the female of the present subspecies has like the male broad, uninterrupted, bands on all of its tergites, but in the specimens on which this description is based these bands are red (probably due to cyanide staining) and do not present a particularly strong contrast to the light brown apical rima.

In the absence or virtual absence of black on the abdomen the subspecies *colombiae* differs not only from typical *gregarium* but also from the related *heathi* described by Cockerell and from *longipes* Friese.

In its ornamentation *colombiae* is much like *Hypanthidium panamense*. Its mesopleura, however, in contrast to the largely yellow mesopleura of *panamense*, are wholly black or with only a much reduced maculation, and the band along the inner margin of the eyes is confluent with that encircling the head; the antennae of the male differ from the ferruginous antennae of *panamense*, not only by their crenulate structure and length, but the presence of black maculations approximately as described by Schrottky in the case of the typical subspecies of *gregarium*. A rather close superficial resemblance obtains, also, between *colombiae* and *curranii* as indicated in the discussion of the latter.

What Friese (1925) described as *Anthidium longipes* would seem to be close structurally to *gregarium*. Friese mentions a small tooth in the emargination between the two long lateral teeth of the seventh tergite. Of this there is only the barest trace—so feeble that it scarcely deserves mention—in the specimens of *gregarium* before me, and sternites 4 and 5 of *gregarium*, not 2-4, as indicated for *longipes*, have a small lobelike extension at each of their lateral extremities. However, these prolongations on the sternites of *gregarium* are less developed than are the lobelike to spinelike lateral extremities on its tergites. Of such formations on the tergites of *longipes* there is no mention in the description of *longipes*.

The type and allotype of subspecies *colombiae* are in the British Museum. The type was collected by Dr. G. Salt at Rio Frio, Magdalena, Colombia, on Nov 29, 1926; the allotype and paratype are from the same locality but were collected respectively on July 13 and July 17, 1927. The paratype is in the American Museum.

A good deal of diversity of opinion has been expressed regarding the genus to which *gregarium* should be assigned. Schrottky in describing it placed it in *Hypanthidium*. The possession of a pulvillus would seem, however, to bar it from *Hypanthidium* as well as from *Anthidium*, in which Strand placed it. Cockerell referred both *gregarium* and *heathi* to "an aberrant section of *Dianthidium*." The specimens before me lack the scalelike tubercles that are present in typical *Dianthidium* and the equally characteristic spine on the third coxae is either merely in a formative stage or obsolescent, being barely traceable. Cockerell (1927, Proc. U. S. Nat. Mus., LXXI, Art 12, p. 3) placed *arenarium*, a close relative of *gregarium*, and possibly an even closer relative of *heathi*, in the subgenus *Anthodiocetes*. Cockerell's *heathi*, like part of the type material of Ducke's *arenarium*, was collected in Parahyba. My impression is that these insects—*gregarium*, *arenarium*, *curranii*, *subarenarium*, and probably *heathi* and *longipes*—represent a division in *Dianthidium* that leans toward *Hypanthidium*.

The following key to the males of *curranii*, *gregarium* subsp. *colombiae*, *arenarium*, and *subarenarium* may be of aid in differentiating these rather closely related species:

- 1.—The two lateral spines that terminate the seventh tergite wholly yellow and ferruginous, and relatively short, each about half as long as the distance that separates the base of the one from the base of the other. The sixth tergite with a tuberculate prominence at the middle of its apical edge. The antennae relatively short, not extending beyond the tegulae. *curranii*.

The two lateral spines that terminate the seventh tergite black-tipped and relatively long, each about two-thirds as long as the distance that separates the base of the one from the base of the other. The sixth tergite without a tuberculate prominence at the middle of its apical edge. The antennae very long, all of the joints being much longer than broad. When extended backward, the antennae reach about to the apex of the scutellum.... 2.

- 2.—The third sternite with two rather narrowly separated reddish spines at the middle of its apex. No fringe-like or comblike arrangement of the hairs along the base of this sternite, but numerous short hairs (much longer at the sides) over its surface..... *subarenarium*.

The third sternite without spines but with two scalelike lobes separated by a cleft. This sternite is largely hairless over its exposed surface but has a tuft of hairs protruding from beneath on each side of the median cleft, and its base has a single row of rather stiff hairs that are graded in size, being small at the middle but long and tuftlike at the lateral extremities. 3.

- 3.—The antennae beyond joint 4 crenulate below. The basal fringe on sternite 3, conspicuous and ferruginous. Sternite 4 has at its middle a small blade-like triangular process that is usually concealed, however, because the two apical tergites tend to fold back upon the venter. *gregarium* subsp. *colombiae*.

The antennae normal. The basal fringe on sternite 3 relatively inconspicuous and pale. Sternite 4 with two small, rather bulbous, dark brown stalks at the center, each of which terminates in a small, four-toothed comb. At each of the lateral extremities of sternite 4 there is a large, uppointing finger-like spine. Sternite 4 is usually concealed, however, because the two terminal tergites tend to fold back under the venter.... *arenarium*.

Dianthidium subarenarium, new species

MALE.—The head dull, very densely, deeply and rather uniformly punctured. The mandibles tridentate, the outermost tooth the largest. The clypeus broader than long. The region between the antennae raised, flanked on each side by a carina; these carinae converging below. The antennae simple, not crenulate below, all of the joints longer than broad, the basal joints of the flagellum being the least elongated. The following maculations are yellow: mandibles except the teeth and the outer half of the base, clypeus except a narrow area along the base and sides, the interantennal carinae faintly, the inner orbits of the eye tapering to about the level of the anterior ocellus, a line back of the ocelli extending from a little beyond the summit of one eye to a little beyond the summit of the other. The scape ferruginous and the three or four subsequent joints largely or wholly ferruginous, those beyond dark at least above and somewhat invaded by blackish also below, the two or three apical joints dark both below and above.

The mesonotum with punctation much like that of the head. The pleura with somewhat larger, less dull punctures. The scutellum rather short and apically broad, slightly emarginate at the middle posteriorly. The propodeum basally with a row, medianly discontinuous, of narrow and inconspicuous pits. The tubercles down-sloping, rather coarsely punctured, with their anterior end slightly carinate. The red tegulae rather densely covered with small but rather deep punctures. L-shaped borders of yellow on the mesonotum, the longer arm of the L being along the side, and a narrow band posteriorly on the axillae and scutellum.

The forelegs ferruginous except for the black coxae and trochanters and a darkened area on the femora above. The middle legs rather more extensively black on the femora, otherwise like the fore legs. The hind legs have the following parts ferruginous: a spot on the coxae, the apex of the femora, the tibiae except for an extensive dark area on the outer surface, the calcaria, the basitarsi and the next succeeding tarsal joint, and the basal half of the claws. The apical half of the claws of all of the legs is dark.

The wings subhyaline but the forewing distinctly darker anteriorly, particularly so in the marginal cell. The venation fuscous. The marginal cell with a small appendix or thickening at the lower extremity of its apex. The second recurrent vein extends well beyond the second transverse cubital vein but not quite so far as the first recurrent vein extends beyond the first transverse cubital vein. The two submarginal cells subequal in size. The two transverse cubital veins converging above, the second transverse cubital rather sinuous but not quite so sinuous as the second recurrent vein.

The tergites of the abdomen very densely covered with small, deep punctures. The punctures are a little larger at the base of each tergite than at the apex, but there is a very narrow apical rim on tergites 2-5 that is impunctate and slightly reflexed. These rims semitransparent and brownish ferruginous. The punctured part of the tergites rather dull. Tergites 1-2 dull reddish basally, blackish apically, with a rather diffuse yellowish maculation at the lateral extremities of each, the maculations on tergite 2 being smaller than those on tergite 1. Tergites 3-6 blackish, with continuous bands of dull yellow that are heavier from tergite to tergite, but even on tergite 6 occupy only about half the tergite. Tergite 7 briefly black basally, yellow beyond to the inclusion of its two long lateral spines only the apical tips of which are darkened. The sternites with a tendency to be dark basally, dull yellowish or ferruginous apically, but without strong contrast. Sternite 3 has two small, narrowly separated teeth at the middle of its apex. Sternites 4 and 5 with a spinelike termination at each lateral extremity. Of the tergites only tergite 7 is armed.

The hair for the most part pale (a little yellowish on the front and vertex), longest perhaps at the sides of sternite 2 but not conspicuously long even there.

Length, 6 mm.; length of forewing, including tegula, 6 mm.

The description is based on a single specimen (British Museum) from Brazil, the ink on the label being so faded through age that the specific locality is indecipherable. Tergite 7 is folded under the abdomen, concealing the apical sternites. Due to the age and condition of the specimen I have thought it inadvisable to try to relax it and reveal the concealed parts. The presence of the teeth or spines at the middle of the apex of sternite 3, however, separates this species from the rather closely related *arenarium*, *heathi*,¹ *gregarium* subspecies *colombiae*, and

¹Professor Cockerell very kindly supplied me with a diagram of sternite 3 of *heathi*. The sternite in question has a median longitudinal groove or cleft suggestive of the condition in *arenarium* and *gregarium* subspecies *colombiae*, and the diagram shows a hairy tuft, too, at each side of the base of this sternite. This sternite of *heathi* lacks the spines at the middle of the apex that are present on sternite 3 of *arenarium*. Professor Cockerell states in his comments accompanying the diagram "The type of *heathi* has 2 black spots or small tubercles on sternite 3, as shown (the diagram indicates as the position of these spots not the apex but the central region of the sternite, each spot a little to one side of the median longitudinal groove or cleft). I had to see them and on, as it were, and they might look more specklike in another view, but I should call them small tubercles." The specimens of *arenarium*, *arenarium*, and *gregarium* subspecies *colombiae* before me do not seem to share this character.

presumably also from *longipes* as this character is not mentioned in the description of *longipes*. From *gregarium* and *longipes* it differs furthermore in having the flagellum simple, not crenulate below. See key in connection with *gregarium* subspecies *colombiae* (pp. 18-19).

Dianthidium (Anthodiocetes) megachiloides (Holmberg)

One female (National Museum) collected at S. Bernardino, Paraguay, Nov. 2, flying in forest (K. Fiebrig)

Dianthidium (Anthodiocetes) nectarinoides (Schroettky)

One female and one male (National Museum) from Campinas, São Paulo, Brazil, Jan 30, 1901.

Dianthidium (Anthodiocetes) agnatum (Cresson) and

Dianthidium (Anthodiocetes) calcaratum (Fries)

Fries's *calcaratum*, described doubtfully as a *Stelis* (1921, Stettiner Entomologische Zeitung, LXXXII, p 96) is structurally virtually identical and in its maculations much like Cresson's *agnatum*, also in my estimation an *Anthodiocetes*. Both are characterized by exceedingly large and deep punctures on the head, on the thorax, and on the sides of the abdominal tergites. Along the middle of the abdominal tergites the punctures are much finer, particularly so in the case of *calcaratum*. Both insects have along the base of the propodeum an uninterrupted row of deep, conspicuous, subrectangular pits horizontally placed, and tergite 7 in the males of both is exceedingly short and virtually undifferentiated from tergite 6 except as to size. In respect to tergite 7 both resemble the male of *salti* and presumably also of certain other *Anthodiocetes* listed in connection with *salti* (see p. 25). The wings of *agnatum* and *calcaratum* are slightly fuliginous, with the costal margin of the forewings a little darker. The males differ in their maculations as follows:

Clypeus entirely yellow. A dot on each side of tergite 1 and sometimes a maculation on each side of tergite 2 as well. *agnatum*.

Clypeus black with its anterior margin rather broadly banded with yellow, the band sometimes interrupted in the middle. Tergites 1-2 immaculate... *calcaratum*.

There is in the American Museum a series, both males and females, of *calcaratum* from San José, Costa Rica, including a specimen of Fries's type material. Cresson's *agnatum*, the type of which I have examined, is from Mexico. A male specimen (British Museum) from Atoyac, Vera Cruz, collected by Schumann, is in my estimation to be considered an

agnatum, although it has maculations on each side of tergite 2 (not specified by Cresson) as well as on each side of tergite 1.

***Dianthidium* (*Anthodictes*) *zebratum* (Schrottky)**

Dianthidium zebratum SCHROTTKY, 1905, *Anales Cientificos Paraguayos*, (1), No. 4, pp. 7-8, 12; 1908, *Anales de la Sociedad Cientifica Argentina*, LXV, p. 230. COCKERELL, 1914, *Proc. U. S. Nat. Mus.*, XLVII, p. 93.

Dianthidium itapuense SCHROTTKY, 1920, *Revista do Museu Paulista*, XII, part 2, pp. 210-211.

Several females from Argentina and Paraguay must be referred, I think, to this species, although the abdominal maculations differ somewhat from those of Schrottky's description and the specimens differ, too, among themselves. In all of them there are merely two widely separated lateral spots on tergite 1, and the narrow bands on tergites 2-3 are without interruption medianly (in Schrottky's specimens "all the bands except the first lightly interrupted in the middle"). In the case of tergites 4-5 the specimen from Posadas in Misiones (from which Schrottky's female was described) has the narrow bands very slightly interrupted medianly; in a specimen from Bompland, also in Misiones, the bands on these tergites are uninterrupted medianly. In the Paraguay specimens, on the other hand, the interruption of the bands on tergites 4-5 is a wide one, and these tergites would better be described as quadrimaculate, with the inner maculations much the larger.

If I have interpreted Schrottky's species correctly, it belongs in the subgenus *Anthodictes*. The females before me have the base of the propodeum with a row of large, deep pits as in *salti*, which is also the condition in what I have interpreted as *megachiloides*, the type species of *Anthodictes*. The proportions of the labial palpi seem in both *salti* and *zebratum* as here interpreted to approach those indicated for *megachiloides*. The description of the male pygidium of *zebratum*, in which mention is made of a "small tooth on each side," is suggestive of the condition in *gualanense*.

Schrottky (1920, *Revista do Museu Paulista*, XII, part 2, pp. 210-211) changed the name of this species, which he originally designated *zebratum*, to *itapuense* because Cresson had described a *zebratum* from North America. Cresson's species is, however, a *Heteranthidium*, not a *Dianthidium*, and, if one is prepared to recognize generic distinctions within the Anthidiinae, *zebratum* would still be a valid name for Schrottky's insect.

The female specimens (British Museum, National Museum, and

American Museum) here discussed are from the following localities: Bompland, Misiones Territory, Argentina, Jan. 13-14, 1927 (F. and M. Edwards); Posadas, Misiones Territory, Argentina, Jan. 14-15, 1927 (F. and M. Edwards); S. Bernardina, Paraguay, Dec. 27-29 (K. Fiebrig).

Dianthidium (Anthodioctes) salti, new species

MALE.—Head black with a yellow maculation occupying the apical half of the clypeus exclusive of the narrow apical edge; a small and narrow triangular maculation (little more than a stripe) on each side of the face, terminated above at the level of the base of the antennae, and a thin, very fragmentary band across the vertex from a level a little beyond the summit of one eye to a level a little beyond the summit of the other. The punctures are rather small and dull in the supraclypeal area and between the low, inconspicuous, interantennal ridges, which are widely separated and converge below; the punctures are larger and coarser on the clypeus and on the front, and very large on the cheeks; those in the supraclypeal area and on the front bear evidence here and there of tessellation; those on the cheeks are shiny. The posterior rim of the cheeks is raised keel-like and there is a carina, too, flanking the innermost row of punctures on the cheek. The mandibles tridentate, with the outermost tooth much more conspicuous than the two succeeding ones. The apical edge of the clypeus with a pair of minute denticles on each side of the center, the inner teeth of each pair being somewhat more developed than the outer teeth. All of the joints of the antennae black above as well as below except the third joint, which is largely red; the joints from the fourth on about one and one-quarter to one and one-half times as long as broad.

The thorax black, immaculate except for a small yellow spot on each of the axillae. The punctuation of the thorax large, distinct, and dense like that of the front and with superimposed tessellation traceable, especially in the punctures of the mesonotum. The suture between the mesonotum and scutellum deep and impunctate, shiny, and the scutellum itself rather short and entire, not emarginate at the middle of its posterior rim. The base of the propodeum with a row of subrectangular spaces or pits of subequal size formed by a number of short, longitudinal, more or less parallel carinae. These subrectangular spaces are dull with a dense, uniform, microscopic tessellation, which extends over the entire propodeum to the inclusion of the rather ill-defined and in its sculpturing undifferentiated enclosure. The tubercles black, shiny, down-slanting and with an erect, low, sharp carina on their anterior edge. The tegulae black, finely punctate.

The legs wholly black except for the apical joint of the tarsi, which is slightly tinged with reddish. The calcaria black.

The wings with a little fuscous staining and a streak of that hue in the apical half of the marginal cell, which has a minute appendix at its tip. The first submarginal cell barely larger than the second. The second recurrent vein extends a considerable distance beyond the second transverse cubital, almost exactly the same distance by which the first recurrent vein extends beyond the first transverse cubital. The first and second transverse cubital veins convergent above, the first straight, the second with a slight sinuation, less anuuous than is the second recurrent vein. The venation dark brown; the stigma rather light brown.

The punctures of the tergites of the abdomen dense (especially in the case of the

two basal ones) but much finer and smaller than the punctures on the head and thorax, being distinctly dainty in contrast. The punctation extends to the apical rims of the tergites, only the extreme edge of tergites 4 and 5 being uninvaded by punctures. A carina encircling the basal concavity of the abdomen. Tergite 1 and 2 are immaculate. Tergites 3-5 have a broad, rich yellow, uninterrupted band, so broad that when the abdomen is retracted only the apical rims show dark; tergites 6-7 are almost exclusively yellow. The apical tergite is short, entire, with very much the appearance of the sixth tergite except that it is much smaller.

The hair of this insect is for the most part black or fuscous. The hairs are predominantly dark on the head and on the mesonotum and mesopleura, and, though not dense, are relatively long, especially on the front, vertex, mesonotum, and scutellum. On the under side of the coxae, trochanters, and even the femora the hairs incline to gray, but the prevailing color of the hairs of the legs is black, even the hair on the under side of the tarsi being dark. The hair on the abdominal tergites is scant, short, and for the most part pale. The basal part of the venter relatively glabrous but the median and apical sternites covered rather densely with silvery, rather plumose hairs.

Length, $5\frac{1}{4}$ mm; width of thorax, 2 mm; length of forewing, including tegula, $5\frac{1}{4}$ mm.

FEMALE—The female rather similar in appearance to the male. The mandibles with two strong teeth at the outer half of the apex and with at most a slight undulation on the inner half that suggests two additional obsolescent teeth, but even these faint vestiges sometimes absent. The denticles on the margin of the clypeus (two on each side of the middle) of about equal size. The sculpturing and punctation about as in the male, but an irregular, longitudinal carina traceable in some of the specimens in the supraclypeal area and extending down the basal half of the clypeus. The inner orbits of the eyes bounded by a thin stripe of yellow to about the level of the base of the antennae and a similar very narrow band along the vertex posteriorly, usually not or only slightly interrupted. The clypeus devoid of maculations except in one specimen, in which a small spot is traceable on each side. The joints near the base of the flagellum somewhat broader than long; those nearer the apex subequal in breadth and length; the apical joint longer than broad. The fourth joint of the antennae and sometimes the apex of the first joint reddish, the other joints black both above and below.

The thorax, legs, and wings as described for the male.

The abdomen with a dull, somewhat diffuse, broad, basal, orange to reddish band on tergite 1 and a dull orange to reddish band of variable thickness (sometimes nearly extinguished) on tergite 2. These bands in their dull, lusterless quality contrast with the more sharply outlined, yellow bands on tergites 3-5 and the largely to wholly yellow tergite 6. The band on tergite 3 is thinner than that of the subsequent tergites. The sternites are wholly yellowish red.

The hairs even more prevalently dark than in the male, almost exclusively black except for the copper-colored hairs fringing the apex of the clypeus and the silvery ventral scopa.

Length, about 7 mm; width of thorax, $2\frac{1}{2}$ to $2\frac{3}{4}$ mm; length of forewing, including tegula, 7 to $7\frac{1}{4}$ mm.

The specimens were all collected at Vista Nieve, Santa Marta, Colombia, elevation 5000 feet. The holotype was collected by G. Salt

on Feb 10, 1927; the allotype and paratypes by "M. A. C." on Dec. 19, 1922, Oct. 29, 1923, and Feb. 18, 1927. The holotype, allotype, and three of the paratypes are in the British Museum, a fourth paratype is in the American Museum.

In its virtually immaculate thorax and its wholly immaculate legs, contrasted with a rather fully maculated abdomen, and in the predominance furthermore of black hairs over most of the body contrasted with the silvery scopa of the venter, *Dianthidium salti* has a combination of superficial characters that make its differentiation from most Neotropical Anthidinae rather easy.

In Cockerell's "Key to Species Belonging to, or Resembling, *Anthodiotes*" (1927, Proc. U. S. Nat. Mus., LXXI, Art. 12) *salti* runs close to *megachiloides* Holmberg. The description of the male of *megachiloides* does not indicate the structure of tergite 7, which may mean that, like tergite 7 of *salti*, it is undifferentiated from the preceding segments. In Holmberg's insect the hairs are prevailingly pale (black in *salti*), the calcaria testaceous-ferruginous (black in *salti*), the wings fulvous at their base (fuscous in *salti*), tergites 1-2 black (with dull red bands in at least the female of *salti*), etc.

It would seem, judging from the description, that tergite 7 of the males of the following species is possibly like that of tergite 7 of the male of *salti*.

duckeii (Segment 7¹ "merely rounded, without armature")

radiale (Segment 7 "small, simple")

callorhinum ("apex broadly rounded")

chrysurum ("apex broadly rounded, slightly truncate")

napirensis ("apex broadly rounded, without teeth")

From all of these species *salti* differs in having prevailingly black hair, the other species just mentioned having respectively "scarcely a remnant of brown hair," "gray-yellow," "extremely scanty," "long rufous," and "scanty whitish hair."

From *duckeii* it differs, in addition, in having the mesonotum and scutellum unmaculated, the calcaria black, not red; from *radiale*, in not having wings that are basally ferruginous, from *callorhinum* and *chrysurum* in having the mesonotum and scutellum unmaculated.

***Anthidium pygmaeum* Friese and *Dianthidium gualanense* Cockerell**

I have seen the type of neither *pygmaeum*, described by Friese, in 1910, from Para, Brazil, on the basis of the female, nor the type of

¹The statement is "segment 1" but I think almost certainly it should read "segment 7."

gualanense, described by Cockerell, in 1912, from Guatemala on the basis of the male. It would seem, however, that structurally these two insects are very similar. Notwithstanding their diminutive size (each insect is 5 mm. in length), they are characterized by very large coarse punctures, and at the base of their metathorax are strong grooves with prominent ridges separating them. In each insect the strongly punctured abdomen has a spot on each side of tergites 1-2 and bands on the subsequent tergites except that in *pygmaeum* tergite 6 is immaculate (possibly a variable character). It is in the thoracic markings that the most tangible differences in the descriptions of the two insects occur, the thorax of *gualanense* being "wholly without light markings" but that of *pygmaeum* extensively maculated.

A male (British Museum) from R. Papagaio, State of Guerrero, Mexico, collected by H. H. Smith at an elevation of 1200 feet, conforms structurally and in its maculations to *gualanense* as described by Cockerell except that it lacks the following maculations: spot on mandibles, occipital band, and lateral patches on first two tergites. A female (British Museum) taken by the same collector in October at Tierra Colorada, State of Guerrero, at an elevation of 2000 feet, presents the undermaculated condition that characterizes the male from the same state.

In contrast to these two specimens there is yet another male (British Museum) collected at Atoyac, Vera Cruz, by Schumann, that in its maculations is suggestive of the female described by Friese as *pygmaeum*. If one excepts what are presumably sexual differences, namely, the fully maculated clypeus of this male and the presence of a narrow band on tergite 6 similar to that on tergites 3-5, then the only part in the description of *pygmaeum* that does not apply to the Atoyac specimen is the coloration of the legs, both the middle and hind legs of the Atoyac specimen being dark with a pale yellow stripe beneath on the apical half of the middle femora.

I have discussed *iheringi* in connection with *currani*, but structurally *iheringi* may be closer to *gualanense*. Certainly the description of the punctation of *iheringi* as "everywhere dense and coarse" and of its tergite 7 as "blunt and with a tiny tooth on each side" would apply with equal accuracy to the male of *gualanense*. It may be, therefore, that we have here three structurally identical or nearly identical forms: namely, a highly maculated form (*iheringi*), an intermediate form (*pygmaeum*), and an undermaculated form (*gualanense*). The fact that two of them, *iheringi* and *gualanense*, have been described as *Dianthidium* and the third, *pygmaeum*, as an *Anthidium* is of no significance due to the

divergent interpretations of different authors regarding the generic and subgeneric divisions within the Anthidiinæ. The specimens before me seem to ally themselves with the subgenus *Anthodiocetes*.

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SOME NEOTROPICAL ANTHIDIINAE: *PARANTHIDIUM*, *ANTHIDIELLUM*, AND *HYPANTHIDIUM*

By HERBERT F. SCHWARZ

In this paper are included certain other subdivisions of the Anthidiinae not considered in a previous issue of Novitates. The report is based on specimens kindly loaned by the British Museum, the National Museum, and by Dr. Joseph Bequaert, as well as on specimens in the collection of the American Museum.

To Miss Grace Sandhouse of the U. S. National Museum and to Mr. Robert B. Benson of the British Museum I am indebted for their kindness in interpreting for me certain of the types in their respective museums, and to Dr. V. S. L. Pate for comparing specimens of *auricollae* Friese with Cresson's type of *apicale*.

Paranthidium gabbii (Cresson)

One female collected at Geronimo, Guatemala, by Champion.

Paranthidium jugatorum (Cresson)

Six females, Mexico City (received from A. C. Baker). The specimens (National Museum and American Museum) were taken "in trap with turpentine."

Paranthidium macrurum (Cockerell)

Dianthidium macrurum COCKERELL, 1913, *Annals and Mag. Nat. Hist.*, (8) XII, p. 107, male; 1914, *Proc. U. S. Nat. Mus.*, XLVII, p. 92.

FEMALE—Rust-red to nearly blood-red, with a minimum of black and yellow. Head with large, deep, coarse punctures that are dense but not confluent, the narrow intervening spaces and the depths of the punctures themselves covered with a microscopic tessellation that is most readily traced in the black areas on the front and in the supraclypeal region. Two rounded ridges or swellings that are inslanting below, between the antennae, a little less densely punctate on their summit than on their side. The mandibles long and overlapping, relatively slender at the base but with a broad, back-slanting apical edge of rather unbroken contour, there being only a slight irregularity in the surface between the fairly prominent outer tooth and the inner angle.¹

¹It is hard to say to what extent this linear contour may be due to wear. Slight irregularities are present on the apical edge of the mandibles of specimens of *Paranthidium jugatorum* and *lepidum*, which mandibles are otherwise very similar to those of *macrurum*. In a fresh specimen of *Paranthidium perpicum* the mandibles are obtusely quadridentate.

This long, rather regular, apical edge is not much shorter than the interior edge, giving the mandible almost the proportions of a low isosceles triangle of which the outer edge is the base. The clypeus quadridentate to quinquedentate along the middle of its apex, rounded and semitransparent on each side of the apex. The five basal segments of the antennae and the base of the sixth orange-colored to red, the segments beyond coal-black both above and below. The four orange-colored basal segments of the flagellum shorter than the black ones. The head rust-red except for a slight infusion of yellow at the lower end of the broad, heavy, rust-red bands along the inner orbits of the eye, and black on the following parts: apex and basal prominences of mandibles, teeth at apex of clypeus, and an area of irregular outline, rather paralleled below, broader and more or less rounded above, extending from the upper edge of the clypeus to include the ocelli. In this black area, however, are two rust-red maculations; one linear, extending downward from the anterior ocellus, and the other spear-shaped to quadrate, occupying the space between the interantennal ridges or swellings. These two maculations are virtually united, suggesting a spear or hammer and its shaft.

The mesonotum with punctures similar to those on the head; rather larger punctures on the mesopleura and scutellum. The tegulae densely covered with considerably smaller punctures. The propodeum densely, distinctly, and rather finely punctate-tessellate over its entire surface. The tubercles scalelike, slightly upturned along their anterior half and covered except on their anterior edge with blotchy, large but vague punctures. The scutellum subtriangular in shape, rather straight-sided and with a short posterior end that is almost truncate (but wholly different in appearance from the scutellum of Anthidiinae that have been assigned to *Pachyanthidium* and *Anthidellum*). The following parts are rust-red to blood-red: mesonotum (entirely so in one specimen; with L-shaped figures of deep-orange hue in the anterolateral angles of the other); the mesopleura (almost wholly so in the first specimen, on their upper half in the second); the axillae and scutellum; the tubercles and tegulae; the upper half of the metapleura (in the first specimen).

The coxae mostly black and the trochanters with some black discoloration in the red (especially marked in the second specimen); the femora and tibiae largely rust-red, with a splash of black on the under side of the hind femora of the second specimen and black at the apex of the hind tibiae of both specimens; there is a splash of black, too, at the base of the otherwise largely rust-red hind basitarsi; the fore and middle basitarsi as well as the other tarsal joints largely dull, pale yellowish, and a faint, pale yellow streak at the base also of all the tibiae (barely traceable in the second specimen).

The wings of rather dark brown stain, with brownish venation. The stigma orange-colored. The marginal cell without an appendix at the apex. The second submarginal cell considerably longer than the first submarginal cell. The second recurrent vein extends only slightly beyond the second transverse cubital vein¹; the first recurrent vein extends a considerable distance beyond the first transverse cubital vein.

The tergites of the abdomen rust-red (their apices rather darker) with a suboval yellow maculation on each side of the first five tergites of the first specimen (in the second specimen these yellow maculations are submerged in the prevailing rust-red). The punctuation of the abdomen is large and coarse, with evidences of superimposed

¹Cockerell in describing the male of *D. maerurum* found the "second r n going well beyond second s m."

tessellation. The apical rims of the tergites are brown and smooth. On the venter there is black on the bases of the sternites even when the apices are rust-red.

The ventral scopa is silvery to ochraceous at the base but becomes increasingly yellowish as the apex is approached, being reddish golden on the last sternite. Yellow to golden, too, are the much shorter hairs on the face, vertex, thorax above, over most of the legs, and on the tergites of the abdomen. The hairs are silvery gray on the anterior part of the cheeks, on the pleura and abdomen beneath, and on the coxae, especially those of the hind pair of legs.

Length, $9\frac{1}{2}$ to 11 mm ; width of thorax, $3\frac{1}{2}$ to 4 mm ; length of forewing, including tegula, 10 to 11 mm

The first specimen, which I designate the allotype (British Museum), was collected by H. H. Smith at Venta de Zopilote, Guerrero, Mexico, at an elevation of 2800 feet; the second (American Museum) was also collected by Smith at R. Papagaio, Guerrero, at an elevation of 1200 feet.

In spite of slight differences of detail (the most serious being that referring to the distance by which the second recurrent nervure extends beyond the second transverse cubital vein) these insects accord in so many essentials with what Cockerell has described on the basis of the male as *macrurum* that I feel reasonably certain they are the hitherto undescribed female of that species

The ridges converging below between the antennae and the rather distinctive mandibles are structures worthy of emphasis. The inter-antennal ridges are not so sharply carinate as in some *Hypanthidium*; rather do these ridges resemble the similar structures in *Paranthidium texanum*. The mandibles are very like those of *Paranthidium jugatorium*, *Paranthidium lepidum*, etc. Judging from Cockerell's description of the pygidium of the male, that structure must closely resemble, if indeed it is not identical with, the pygidium of *Paranthidium arizonicum* and *Paranthidium texanum*. I have compared the females here described with a female of *texanum* and find the structural resemblance very close. They accord with *texanum* in the shape and sculpturing of the head, approximately in the dentition of the apex of the clypeus, in the character of the interantennal ridges, and the relationship of the joints of the antennae. The thoracic structure is the same for both species even to the inclusion of the rather triangular scutellum with its briefly truncated apex, the punctate-tessellate sculpturing of the propodeum, and the dense but rather fine punctation of the tegulae. The abdominal punctures seem to me rather less dense in *texanum*, but the different color of the tergites tends to make accurate comparison of the punctures difficult. Curiously enough, the second recurrent nervure is in the specimen of *texanum* rather farther beyond the second transverse cubital than is the

case in the females of *macrurum*, and this character may be a variable one. I suspect variability may occur, too, in the degree of recession of the apical edge of the mandible, for while the mandible of the female specimen of *texanum* is similar in character to that of *macrurum*, its apical edge is somewhat more abbreviated.

***Anthidiellum robertsoni* (Cockerell)**

Two females and one male, all collected by H. H. Smith: one of the females at Soledad, Guerrero, Mexico, at an elevation of 5500 feet, in July, the other female at Rincon, Guerrero, at an elevation of 2800 feet, in September, the male at Cuernavaca, Morelos, Mexico, in June. Two of the specimens (a male and a female) are in the British Museum; the second female is in the collection of the American Museum.

***Anthidiellum toltecum* (Cresson)**

Three males, all collected at Atoyac, Vera Cruz, Mexico, by H. H. Smith, in April and May. Two of the specimens are in the British Museum; the third specimen is in the American Museum.

***Anthidiellum apicale* (Cresson) and *Anthidiellum auricollae* (Friese)**

Anthidium apicale CRESSON, 1878, Trans. Amer. Ent. Soc., VII, p. 116. FRIESE, 1911, 'Das Tierreich,' 28. Lieferung, pp. 391, 393-394.

Dianthidium apicale, COCKERELL, 1904, Ann. Mag. Nat. Hist., (7) XIV, p. 206; 1904, Bull. Southern Calif. Acad. Sci., III, p. 6; 1914, Proc. U. S. Nat. Mus., XLVII, p. 91.

It would seem that *Anthidiellum auricollae* (Friese), described from Costa Rica, is structurally the same insect that Cresson had previously described from Mexico as *apicale*. An *Anthidiellum* male taken by Dr. Bequaert at Zacapa, Guatemala, on May 9, 1931, which agrees with a specimen from San Mateo identified by Friese as his *auricollae*, first made me suspicious that *apicale* and *auricollae*, rather contiguous in their range, might be the same. Dr. V. S. L. Pate, to whom I entrusted Friese's specimens, male and female, of *auricollae*, very kindly compared them with Cresson's type material of *apicale*. He has written me as follows:

I compared your specimens of *auricollae* Fr. with those of *apicale* Cr. and found them to all intents and purposes identical, particularly the males. I was unable to get time to relax the types and compare the mandibles. The legs were drawn up rather tightly under the body and likewise a bit difficult to see but in both species appeared the same. The extent of the maculation of the faces of the males differs slightly but not enough to make any real difference. The thoracic and propodeal structure is the same and the structure of the posterior abdominal segments, particularly in the male, is likewise the same. Finally the punctuation is similar throughout.

Subsequently I had a chance myself to confirm Dr. Pate's diagnosis. Cresson's male of *apicale* has merely a basal spot on the first tibiae while in Friese's *auricollae* before me the whole joint is exteriorly yellow ("yellow striped" according to Friese's description), but structurally the insects seem to be the same.

Anthidiellum apicale is fairly closely related to *Anthidiellum perplexum* (Smith) from our southeastern states. Tergite 7 is rather broadly rounded and the lateral apical corners of tergites 3-6 are lobate in the males of both of these insects, but the punctation of the abdominal tergites—especially the basal ones—is much denser and less coarse in *apicale* than is the case in *perplexum*.

***Hypanthidium mexicanum* (Cresson)**

Three females, all collected by H. H. Smith, two of them at Atoyac, Vera Cruz, Mexico, in April, the third at R. Papagaio, Guerrero, at an elevation of 1200 feet, in October. Two of the specimens are in the British Museum; the third is in the American Museum.

***Hypanthidium taboganum* (Cockerell)**

One female, collected by W. M. Wheeler, at Ancon, Canal Zone, on July 17, 1924. The specimen is in the British Museum

***Hypanthidium aureocinctum* subspecies *parapanamense*, new subspecies**

MALE.—The mandibles tridentate, the outermost tooth acute and long, the other two teeth considerably shorter, the innermost one broader but no longer than the median one. Two carinae converging below in the space between the antennae. The eyes strongly convergent below. The malar space obsolete. The head, like the thorax, densely punctured. The punctures largest on the anterior two-thirds of the mesopleura; the posterior one-third of the mesopleura mostly smooth but with diminutive punctures toward the apex. The tubercles carinate above, not scalelike. The scutellum faintly emarginate at its middle posteriorly. Base of metathorax with a series of large, deep pits, the thoracic truncation finely tessellate-punctate over most of its surface. The abdominal tergites much more finely punctate than the head and thorax, and the apex of each tergite more finely punctate than its base. The apical rim of tergite 6 abruptly produced toward the middle, the resulting process occupying in width a little more than a third of the tergite, truncate in shape but terminating at each of its lateral extremities in a rather flat but well-defined tooth. Tergite 7 bilobed on its apical half, each of the lobes being subequal to the rather deep intervening emargination.

The head is black with the following parts chrome-yellow: mandibles except teeth; clypeus except narrow, ferruginous, apical edge; moderately broad stripes, tapering upward along inner orbits of the eyes, terminating at about the level of the anterior ocellus; an interrupted U-shaped figure in the supraclypeal area, the arms of

the U almost coextensive with the interantennal ridges; a continuous band encircling the back of the head; a faint yellow stripe on the light ferruginous scape, the flagellum being of a somewhat sooty ferruginous.

The thorax is black with the following areas chrome-yellow: a spot of variable size on the mesopleura; a specklike maculation near the outer edge of the tegulae; two inverted L-shaped figures on the mesonotum, the long arm of the L along the lateral margin and the shorter arm part way along the anterior margin of the mesonotum, with the brief completing element of the L represented by a stunted discal stripe; a broad stripe on the axillae that is confluent with a narrower stripe rimming the scutellum posteriorly.

The legs black with the following exceptions: yellow spots on the anterior and on the posterior pair of coxae; a yellow stripe on the under side of the anterior femora and sometimes also on the under side of the middle and posterior femora; a ferruginous stripe on the upper side of all the femora; the front tibiae almost wholly ferruginous with an ill-defined, yellowish stripe on their upper side; the middle anteriorly broadly ferruginous invaded by yellow, posteriorly narrowly black; the hind tibiae black, with a vague, small, reddish maculation at the base and a stronger, yellowish maculation at the apex; the basitarsi externally yellowish, those of the middle and hind legs narrowly striped with black posteriorly; the other tarsal joints prevalingly ferruginous but more or less invaded by black, with sooty effect on those of the middle and posterior pair of legs. The tarsal claws without pulvilli.

The abdomen predominantly chrome-yellow but with the following exceptions. on tergite 1 the concavity at the base and a broad area at the apex black; on tergite 2 an area at the base and a broader area at the apex black; on tergite 3 a very narrow area at the base and a reduced area at the apex black; on tergite 4 only the apex rather narrowly dark and with more red than black; on tergite 5 the apex mostly clear ferruginous; on tergite 6 the median prolongation of the rim black, the narrow, unextended part of the rim dull ferruginous; tergite 7 in one specimen with a slightly darkened rim, in the other specimen the rim is hyaline.

The hairs pale and relatively short on the under side and sides of the thorax; long, fairly dense, and pale on the under side of the abdomen; the hairs on the face and dorsal surface of the body pale or somewhat golden. The legs with hairs partly pale, partly golden.

The wings dusky, especially so in the costal region; the first recurrent nervure goes well beyond the first transverse cubital, and the second recurrent nervure is an approximately equal distance beyond the second transverse cubital. There is a small appendix at the lower extremity of the apex of the marginal cell. The venation is brownish; the stigma and the tegulae are orange-colored.

Length, $6\frac{1}{2}$ mm.; width of thorax, $2\frac{1}{2}$ mm.; length of forewing, including tegula, $6\frac{1}{2}$ mm.

FEMALE.—Structurally differentiated from the male as follows: the mandibles quadridentate but with only the two teeth near the outer edge conspicuous and close together, the two teeth toward the inner edge more widely separated and sometimes worn low, giving in such cases the impression of an unbroken cutting edge. The process on the apex of the penultimate tergite of the male utterly lacking in the female, and the apical tergite simple, of uninterrupted, rounded outline.

The maculations very similar to those of the male, differing only as follows: the mandibles more extensively black at the apex; yellow stripes on the under side of all

of the femora in all of the specimens; the yellow stripe that in the male is superimposed on the ferruginous front tibiae lacking; the posterior area of black on the middle tibiae more extensive and the maculation at the apex of the hind tibiae lacking; the basitarsi black and the other tarsal joints darker than in the male, for the most part or wholly black instead of ferruginous. Tergites 1-5 are as described for the male, even in respect to having red replace black on the apex of tergites 4-5; tergite 6 is wholly yellow except for a very narrow margin of black rimming the apex.

The hairs in general like those of the male, distinctly golden on the face and dorsal surface of the body

Length, 6 to $6\frac{1}{2}$ mm; width of thorax, $2\frac{1}{4}$ mm; length of forewing, including tegula, 6 mm.

I was at first inclined to believe this insect distinct from *aureocinctum* because of the allusion in the description of *aureocinctum* to the malar space as yellow, whereas in the insect here described there is no malar space, this being "obsolete" as in Cockerell's *panamense*. Through Mr. Robert B. Benson of the British Museum, who kindly compared a female of *parapanamense* that I sent him with the type of *aureocinctum*, I am informed, however, that while there are differences of coloration between *aureocinctum* and *parapanamense*, structurally he can find very little difference between the two. In *aureocinctum* as in *panamense* and *parapanamense* the malar space is obsolete. Mr. Benson was kind enough to send me a specimen identified by the British Museum as *aureocinctum*. It is one of three specimens from the collection of Godman and Salvin, being taken at Teapa, State of Tabasco, Mexico. Mr. Benson states that the markings on the abdomen of this specimen are "considerably paler than in the type" of *aureocinctum*. Indeed the prevalence of red and yellow on the abdomen of this specimen to the near exclusion of black, verges on the condition present in the also structurally similar *panamense*, and suggests the likelihood of an intergrading and possibly overlapping series of forms throughout Central America in which one extreme is the highly ornamented *panamense* and the other, perhaps, the rather melanistic form *parapanamense*.

Structurally hard to separate from *aureocinctum* and *panamense*, the subspecies *parapanamense* differs superficially from *aureocinctum* in its somewhat more melanistic tendencies, the discal stripes on the mesothorax being merely stumplike, the legs having much black in addition to the merely yellow and red mentioned in the description of *aureocinctum*,¹ and several of the abdominal tergites being apically black instead of "broadly ferruginous."

Structurally the male is virtually identical with what I have

¹In the specimen from Teapa identified as *aureocinctum* the legs are wholly yellow and reddish except for the somewhat black anterior trochanters.

interpreted as the male of *panamense* (1927, Amer. Mus. Novitates, No. 253, p. 17). The female of *parapanamense*, too, seems to accord structurally with the corresponding sex of *panamense*. What at first appeared sharply to differentiate the one female from the other was the quadri-dentate mandible of *parapanamense* as against the bidentate mandible instanced in the original description of *panamense*. Miss Grace Sandhouse of the U. S. National Museum, who kindly relaxed the type specimen of *panamense* in order the better to examine the mandible, has written me, however, as follows: "There are, as you suspected, four teeth, arranged as you described them¹ [in your letter]" This seems to remove doubt as to the essential accord structurally of *panamense* and of *parapanamense* not only in the male but also in the female.

The above descriptions are based on five specimens, two males and three females all collected during February-March, 1931, by J. Bequaert, at Santa Emilia Pochuta, Guatemala, at an elevation of 1000 feet. The holotype, allotype, and one paratype have been deposited by Dr. Bequaert in the Museum of Comparative Zoology of Harvard University; the other two paratypes, male and female, are in the American Museum. The allotype was collected at the flowers of *Baccharis trinervis*. The identification of the plant was made by Mr. Standley from specimens collected by Dr. Bequaert.

HYPANTHIDIUM

(Mexican and Central American forms only)

MALES

[Except *bilobatum* Friese² and *aureocinctum* Cockerell (male unknown) and *melanopterum* Cockerell (male unknown).]

¹Of the four teeth the two at the outer edge are close together and conspicuous, the two toward the inner edge are more widely separated, the fourth tooth constituting indeed the angle of the inner edge.

²Friese based his description of *bilobatum* (which is evidently in its structure rather like *aureocinctum*, *panamense*, and *parapanamense*) on specimens from such widely sundered regions as South Brazil and Paraguay, on the one hand, and San José, Costa Rica, on the other. His description indicates a range of variability in the maculations of the abdomen at least, but it is not clear whether the specimens from San José belong to one extreme or the other, are intermediate between the two, or cover both extremes. The description of both *aureocinctum* and *panamense* antedate *bilobatum* accordingly, if distinctions of maculation be disregarded, *bilobatum* would take rank probably only as a synonym of *aureocinctum* or of one of the South American forms.

Judging from the description, the Brazilian *flavo-pictum* Smith (the type of which is a male with the apical tergite "quadrate, deeply notched in the middle, the notch rounded") is of the general character of the males of *aureocinctum*, *panamense*, *bilobatum*, and *parapanamense*. Duke (1910, Revus d'Entomologie, Ccen, XXVIII, p. 102) makes *flavo-pictum* a synonym of *guitatum* Latrelle, described from the female, and likewise makes *flavomarginatum* Smith and *elegantulum* Smith synonyms of Latrelle's species. If my interpretation of *flavo-pictum* is correct, it would seem that at least *flavomarginatum*, which was described from the male, cannot be considered identical with *flavo-pictum* and hence cannot be made a synonym of *guitatum*, for *flavomarginatum* according to Smith has on tergite 7 "a small, deep impression in the middle, close to the apical margin," which alligns it rather with such forms as *marcescens*, described a year in advance of *flavomarginatum*, and *taboganum*. Schrottiky's *flavomarginatum* subsp. *obscurior*, with its tergite 7 described as "ferrugineo basi nigra latissime bilobata" seems rather to be a subspecies of *flavo-pictum*. Schrottiky's *flavofasciatum*, the female of which has two small, longitudinal stripes between the antennae, seems to belong to the *flavo-pictum* branch of *Hypanthidium*.

[Later] Since the above paragraph was written, Mr. Robert B. Benson has been kind enough to examine the types of *flavo-pictum* and *elegantulum* in the British Museum and has written me as follows:

"*Anthidium elegantulum* Smith is probably the female of *flavo-pictum* Smith as you suggest. The female *elegantulum* has got the two converging carinae in the interantennal space. The male type of *flavo-pictum* has tergite 7 bilobed as you indicate and tergite 6 is produced in the way you speak of (produced and broadly truncate along the middle of its apex)"

- 1—Tergite 6 produced broadly and truncately along the middle of its apex Tergite 7 with its apex bilobed 2.
 Tergite 6 simple. Tergite 7 with its apical margin hyaline and entire, but with a pitlike depression medianly 3.
 2—The legs and abdomen clear ferruginous and yellow. *panamense*.
 The legs variegated with black and several of the basal tergites of the abdomen black banded with yellow *parapanamense*.
 3.—Tergite 1 maculated 4.
 Tergite 1 immaculate *taboganum*.
 4—Tergite 2 immaculate *mexicanum*.
 Tergite 2 laterally maculated *costaricensis*.¹

FEMALES²

- 1.—Two apically converging carinae in the region between the antennae. Clypeus yellow except for the anterior edge 2.
 The region between the antennae without carinae 4.
 2.—Legs yellow with ferruginous or reddish 3.
 Femora black, striped with yellow below and with ferruginous above; middle tibiae black posteriorly; hind tibiae black except for a basal spot; basitarsi and other tarsal joints mostly black. *parapanamense*.
 3—The tergites black at the base, broadly ferruginous at the apex, each with a very broad, entire, chrome-yellow band *aureocinctum*.
 The tergites red and yellow to the exclusion of black *panamense*.
 4.—Tergite 1 black; tergite 2 with a maculation at each extremity *taboganum*.
 Tergite 1 maculated 5.
 5.—Tergite 2 immaculate *mexicanum*.
 Tergite 2 with a small mark on each side *melanopterum*.

¹It is possible that *costaricensis* is the undescribed male of Cockerell's *melanopterum*, but, if so, the female type of *costaricensis* does not belong with the male allotype. Indeed, I find it difficult on the basis of the description to interpret the female of *costaricensis* as a *Hypanthidium* while I think the male is almost certainly of this group. Friese's type material of *costaricensis* included not only specimens from San José, Costa Rica, but also from distant Paraguay. It may well, therefore, have been composite.

²I am indebted to Miss Grace Sandhouse, of the U S National Museum, who kindly examined at my request the type material of *H. melanopterum*, *H. panamense*, and *H. taboganum*, for aid in preparing this key.

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A NEW CATFISH, *AMPHILIUS PICTUS*, AND A DISCUSSION OF A SMALL LIBERIAN COLLECTION OF FISHES

By J. T. NICHOLS AND F. R. LAMONTE

In a small but interesting collection of fishes from Liberia, West Africa, courteously presented to The American Museum of Natural History by Dr. G. W. Harley, we find the following pretty little catfish, which appears to be undescribed.

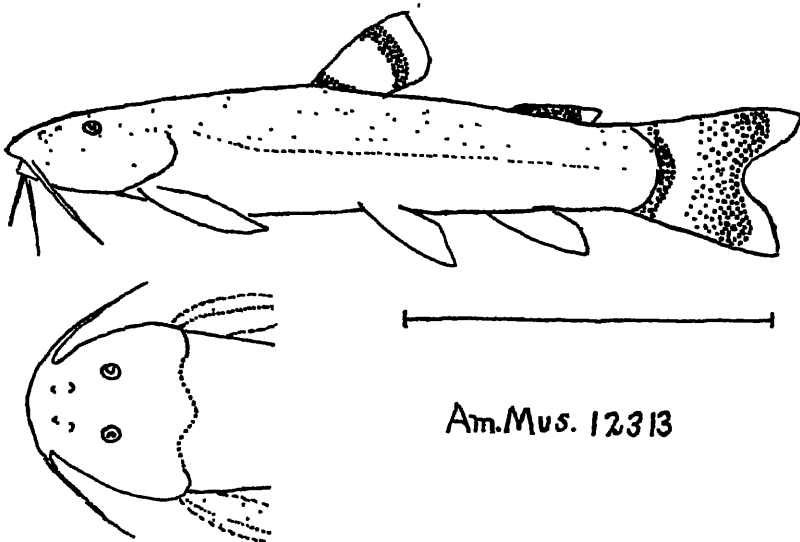


Fig. 1. *Amphilius pictus*, two.

Amphilius pictus, new species

SPECIFIC CHARACTERS—Ventral origin slightly behind middle of dorsal base. Head only slightly longer than broad; snout broadly rounded; interocular width about 2.5 times diameter of eye. Caudal peduncle a little longer than deep. Caudal shallowly forked, with rounded lobes. Maxillary barbel shorter than head. Length of the adipose less than its distance from the dorsal.

DESCRIPTION OF TYPE.—No. 12313, American Museum of Natural History; collected from a stream near Kaleata, Liberia; February, 1932; by Dr. G. W. Harley.

Length to base of caudal, 44 mm., depth in this length, 5; head to end of occipital process, 3.9. Eye in head, 9; snout, 2.1; interorbital, 3; width of mouth, 2; maxillary barbel, 1.4; width of head, 1.1; depth of peduncle, 2; its length, 1.7; base of dorsal, 2; length of adipose, 1.8; interspace between dorsal and adipose, 1.3; height of dorsal, 1.4; of anal, 1.8; length of pectoral, 1.2; of ventral, 1.6; caudal, 1.1.

Dorsal rays, 7 (6 branched); anal, 8 (6 branched); Gill-rakers, 7 on lower limb of first arch.

Head depressed; peduncle compressed, interorbital almost flat; eyes superior, without free rim; lower jaw distinctly included; maxillary barbel not quite reaching posterior angle of gill-cover. Origin of dorsal about equidistant between end of snout and tip of depressed anal.

Body color irregularly dull olive, without distinct markings; belly before the ventrals white. Dorsal dusky at base in front and with a broad blackish cross-band above the middle; middle of adipose more or less dusky; caudal with a blackish bar at its base and a broad blackish subterminal cross-band leaving the tips of the lobes pale; lower fins pale, essentially unmarked.

There are five other specimens with the same data, which range from 32-45 mm. in standard length.

The material received, all from near Kaleata, Liberia, comprises the following:

- 5 *Marcusenius brachistius* Gill
- 12 *Ischthys henryi* Gill
- 2 *Alestes longipinnus* (Günther)
- 2 *Clarias salae* Hubrecht
- 1 *Clarias liberiensis* Steindachner
- 6 *Amphilius pictus* Nichols and LaMonte
- 4 *Hemichromis fasciatus* Peters
- 8 *Hemichromis bimaculatus* Gill
- 5 *Pelmatochromis humilis* Boulenger
- 15 *Haplochromis fasciolatus* Günther

This small collection, our first of fresh-water fishes from Liberia, though too small to be in any sense conclusive, may yet be analyzed as evidence bearing on the relationships of the fresh-water fish-fauna it represents.¹⁻³

It is made up of some 60 specimens (10 species) as follows: mormyrids, 17 (2 species); characins, 2 (1); catfish, 9 (3); cichlids, 17 (3); cyprinodonts, 15 (1).

The locality lies within the general Nile-West African faunal area, where mormyrids, characins, and catfish have been found to be dominant. The proportion of catfish therein contained is comparable to that in the Nile and Congo,² and is higher than in a collection from across the southern border of the faunal area in Angola.¹ In the Congo, mormyrids and

¹Nichols and Boulton, 1927, Amer Mus Novitates, No 264, pp 1-2.

²Nichols, 1928, Amer Mus Novitates, No 319, pp 3-7

characins were found to be about equally balanced, each 18 per cent by species. Across in Angola, the mormyrids still held at 16% per cent, but characins were only 8% per cent; whereas in the Nile collection mormyrids were down to about 12 per cent, characins up to 30 per cent; and in the present small Liberian collection characins are 10 per cent and 2 mormyrids 20 per cent (2 specimens of the former versus 17 of the latter). It may be that the small proportion of characins in the Liberian and Angolan collections is correlated with an ecological factor,—small streams.

In any event, there is thus far nothing to make of Liberia more an outlying part of the general Nile-West African faunal area, than of Angola. However, let us consider the genus *Barbus*: 3 or 4 per cent in Congo and Nile collections; 41% per cent in that from Angola; none in the Liberian collection. Also, the lack of representation of this genus can hardly be assigned to ecological conditions, for (though it is generally poorly represented in the forested West African area) small streams are as a rule favorable for it. The considerable representation of cichlids, 30 per cent (17 specimens confirming the significance of 3 species), is interesting, as compared with only 9 per cent Congo and Nile and 20% per cent Angola; also of interest is the presence in the Liberian collection of cyprinodonts (15 individuals of 1 species), 10 per cent, these being a very minor factor elsewhere. From this, one might get the impression that cichlids have been shouldered aside from the heart of the present strong Nile-Congo fauna, and that there is correlation between abundance of cyprinodonts and a territory that is remote from the point of entrance of the recent *Barbus* invasion of Africa. On other grounds it seems more likely that these two "peripheral" groups infiltrated an established "continental" catfish-characin fauna, than that they were present before Africa's invasion by such, but at least there is the implication that they have been long present and are not a recent invasion as the genus *Barbus* seems to be.

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A LIST OF THE FOSSIL LAND MAMMALS OF JAPAN AND KOREA WITH DESCRIPTIONS OF NEW EOCENE FORMS FROM KOREA

BY SHIGETASU TOKUNAGA

INTRODUCTION

The author has recently visited the Department of Palaeontology at the American Museum of Natural History and has had the opportunity of making comparisons between the Korean fossils briefly described in the following pages and the extensive collection of the Central Asiatic Expedition from Mongolia. He desires to express here his appreciation of the opportunity to publish in *Novitates* the first description of this Korean fauna and the list of Japanese and Korean fossil mammals as known to date.

A mammalian jaw-bone belonging to the genus *Brachyodus*, which was excavated by the author at the Oligocene coal-bed in Kyushu, is assuredly the most ancient land-mammal ever discovered in Japan proper.

A number of specimens described in this paper have been unearthed in the Eocene beds in the northwestern part of Korea. Several kinds of mammals are reported to have been excavated in the Miocene districts of Japan, among which those from Mino are especially worthy of notice.

An interesting species of *Cervurus* which lived in the Pontian age, the author is informed has been discovered in Japan and China. This proves the fact that the islands of Japan were connected with the continent during late Miocene time.

The surest evidence, however, of the land connection of Japan with China and India is given by the proboscideans found abundantly in the older Pleistocene beds of Japan. Whether the land-bridge existed in the older Holocene, still remains to be determined.

Six species of *Rhinoceros* were named provisionally as new species by the author, and their confirmatory studies are now being undertaken.

The species marked with an asterisk in the following list are those common to Japan and continental Asia:

LIST OF THE FOSSIL LAND MAMMALS OF JAPAN AND KOREA

Specific Names	Locality	Oligocene	Miocene	Pliocene	Pleistocene
PRIMATES					
<i>Macacus fuscatus</i> Bly	Kyushu (Buzen)				×
RODENTIA					
Sciurid	Honshu (Mino)		×		
<i>Lepus brachyurus brachyurus</i> Tem	Kyushu (Buzen)				×
CARNIVORA					
<i>Meles anakuma</i> Tem.	Honshu (Shimotsuke), Kyushu (Buzen)				×
PROBOSCIDEA¹					
<i>Hemimastodon annectens</i> Mat. (<i>Serridentinus</i>)	Honshu (Mino)		×		
* <i>Prostegodon latidens</i> (Clift) (<i>Stegolophodon</i>)	Honshu (Hitachi, Rikuzen)		×		
<i>Trilophodon sendaiensis</i> Mat. (<i>Serridentinus</i>)	Honshu (Rikuzen)			×	
* <i>Trilophodon palaeindicus</i> Lyd.	Honshu (Mino)		×		
<i>Parastegodon aurorae</i> Mat. (<i>Stegodon</i>)	Honshu (Kaga)			×	
* <i>Stegodon bonbyfrons</i> Falc. and Caut.	Honshu (Kazusa)			×	
* <i>Stegodon clifti</i> Falc. and Caut.	Honshu (Ise)			×	
* <i>Stegodon orientalis</i> Owen	Honshu (Kazusa, Shi- motsuke, Echigo, Suo), Nagasaki, Inland Sea				×
* <i>Stegodon sinensis</i> Owen	Inland Sea				×
<i>Stegodon</i> sp.	Kyushu (Hyuga)		×		
<i>Parelephas protomammonteus</i> Mat. (<i>Palaeoloxodon</i>)	Honshu (Kazusa)			×	
* <i>Parelephas trogontheri</i> Pohlig	Honshu (Kazusa, Mika- wa, Omi, Shinano), Inland Sea.				×
<i>Loxodonta tokunagai</i> Mat. (<i>Palaeoloxodon</i>)	Honshu (Etchu)			×	
<i>Loxodonta namadica naumanni</i> Mak. 1924 (<i>Palaeoloxodon</i>)	Honshu (Musashi, Toto- mi, Sagami, Hitachi, Kazusa, Mikawa, Shimosa)				×
<i>Elephas namadicus setoensis</i> Mak. 1929 (<i>Palaeoloxodon</i>)	Inland Sea				×

¹The names in parentheses are the generic references which will be used in Professor Henry Fairfield Osborn's forthcoming memoir on the Proboscidea.

LIST OF THE FOSSIL LAND MAMMALS OF JAPAN AND KOREA—Cont.

Specific Names	Locality	Oligocene	Miocene	Pliocene	Plastocene
<i>Loxodonta namadica yabei</i> Mat	Honshu (Ugo, Noto), Inland Sea, Shikoku, Hokaido (Ishikari)				×
<i>Elephas indicus buski</i> Mat.	Honshu (Musashi, Mino, Mutsu)				×
<i>Mastodon</i> , sp.	Korea (Joshin)		?	?	
PERISSODACTYLA					
Equidae					
<i>Anchitherium hypohippoides</i> Mat	Honshu (Mino)		×		
* <i>Equus caballus</i> Linné	Honshu (Hyogo), Korea (Kaikido)				×
Tapiridae					
<i>Palaeotapirus yagi</i> Mat.	Honshu (Mino)		×		
Helaeletidae					
<i>Dematotherium grangeri</i> , sp. nov	Korea (Kokaido) × ¹				
Lophiodontidae					
Lophiodont	Korea (Kokaido) × ¹				
Titanotheriidae					
Titanotheres sp.	Hozan coal mine, North- western Korea × ¹				
Rhinocerotidae					
<i>Teleoceras puginator</i> Mat.	Honshu (Mino)		×		
<i>Rhinoceros (Teleoceras) tokiensis</i> Tok.	Honshu (Mino)		×		
<i>Rhinoceros (Teleoceras?) kaniensis</i> Tok.	Honshu (Mino)		×		
<i>Rhinoceros (Aceratherium?)</i> <i>watanabei</i> Tok.	Honshu (Suo)		×		
<i>Rhinoceros (Aceratherium?) maki</i> Tok	Korea (Kokaido)		×		
<i>Rhinoceros</i> sp.	Honshu (Suo)		×		
<i>Rhinoceros shindoi</i> Tok.	Honshu (Shimotsuke) Kyushu (Buzen)				×
<i>Rhinoceros koreanicus</i> Tok.	Korea (Kaikido)				×
<i>Rhinoceros</i> sp	Taiwan (Taikiei)				×
ARTIODACTYLA					
Anthracotheriidae					
<i>Brachypodus japonicus</i> Mat.	Kyushu (Hizen)	×			

¹Upper Eocene.

LIST OF THE FOSSIL LAND MAMMALS OF JAPAN AND KOREA—*Cont.*

Specific Names	Locality	Oligocene	Miocene	Pliocene	Plastocene
Suidae					
<i>Sus nipponicus</i> Mat.	Honshu (Ugo)				×
<i>Sus leucomystax</i> Tem.	Honshu (Shimotsuke), Kyushu (Buzen)				×
Cervidae					
<i>Amphitragulus minoensis</i> Mat.	Honshu (Mino)		×		
<i>Dicrocerus tokunagai</i> Mat.	Honshu (Iwaki)		×		
<i>Cervus oweni harabayashii</i> Tok.	Honshu (Shinano)		×		
<i>Cervus nippon nippon</i> Tem.	Honshu (Musashi, Shi- motsuke, Ugo), Kyushu (Buzen), Inland Sea				×
<i>Cervus kazusensis</i> Mat.	Honshu (Kazusa)				×
<i>Cervus rukiensis</i> Mat.	Loochoo Is.				×
* <i>Cervus</i> cfr. <i>elaphus</i> Linné	Korea (Heian-nando)				×
<i>Cervus</i> sp.	Honshu (Shimooosa)				×
<i>Cervus</i> sp.	Honshu (Totomi)			?	
<i>Cervus</i> sp.	Honshu (Sagami)			?	
* <i>Elaphurus davidianus</i> M-Edwards	Honshu (Kazusa)				×
<i>Muntiacus astylodon</i> Mat.	Loochoo Is.				×
Giraffidae					
<i>Giraffa nipponica</i> Mat.	Honshu (Kazusa)				×
Bovidae					
<i>Bubalina</i> sp.	Honshu (Omi)			×	
* <i>Bison occidentalis</i> Lucas	Inland Sea				×
* <i>Bibos geron</i> Mat.	Inland Sea				×

EOCENE MAMMALS FROM KOREA

In Kokaido, the northwestern part of Korea, there have been deposited Tertiary strata, in which the Hozan coal seams are found and at the present time coal-mining operations are in progress. The thickness of the principal seam is about 25 feet. The latter is interveined with four or more thin partings and lies near the base of the Tertiary of the region, being separated by only 20-30 feet from the underlying Palaeozoic limestone. Sandy shales with molluscan fossils such as *Mya* and others are found overlying the seam. Because of the scarcity of fossils,



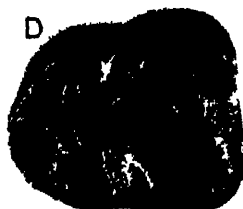
A



B



C



D

Fig. 1.—A Titanotherium, P^2 - 3 right; B Titanotherium, M_1 (?) left; C. Titanotherium, M^3 (?) right All natural size D Lophodont, P_4 right. Twice natural size.

the geological age of the coal-bearing strata had not hitherto been determined. In 1930 the author visited this district, and fortunately collected a number of mammalian remains, securely imbedded in the coal. Mostly they are fragments, but they are very important as they determine the approximate geological age of this horizon.

The more noteworthy of these fossils are the teeth of a titanotheriine, a jaw fragment of *Desmatotherium* and various teeth of the Rhinocerotidae (provisionally named as *Rhinoceros maku* in the present list) and some lophiodont animal (see Fig. 1).

Among the numerous fragments of the teeth of titanotheriines, the author found the following specimens which probably belong to one individual and some of which are shown in Fig. 1 of this paper:

Right lower canine.

Right upper second and third premolars, and second molar.

Left upper third premolar.

Lower third premolar and third molar.

Excepting these isolated teeth, other portions of the skull were entirely broken, so it is too hazardous to assign even a generic name to the present specimens.



Fig. 2.—*Desmatotherium grangeri*, sp. nov. Type specimen. Fragment of left maxilla with P²-P⁴. From the Upper Eocene coal measures of northwestern Korea. Seven-fourths natural size.

Desmatotherium grangeri, sp. nov.

TYPE.—A fragment of the left maxilla with P²-P⁴ well preserved. From the collection of Professor Shigeyasu Tokunaga of Waseda University, Tokyo, Japan.

HORIZON AND LOCALITY.—From the Upper Eocene Hozan coal deposit. Kokaido, northwestern Korea. Collected by Professor Shigeyasu Tokunaga.

DIAGNOSIS.—Size approximately that of *D. mongoliense* from the Irdin Manha beds of Mongolia but differing from both that species and from *D. fissum*, also from

the Irdin Manha beds, by the greater simplicity and less quadrate character of the premolars P^2 and P^3 with a single interior cusp and triangular in outline P^4 with two inner cusps placed close together and separated by shallow groove on the lingual face of the tooth; subquadrate in outline. Enamel crown relatively low, 5 mm in the present species and 6 mm in *D. mongoliense*, measured on the lingual face of the teeth.

The species is readily distinguished from the Mongolian forms, especially in the P^2 and P^3 which in the latter species are distinctly quadrate four-cusped teeth. In the P^4 the resemblance to *D. mongoliense* and *D. fissum* is closer. *D. grangeri* is the most primitive of the three Asiatic species known and may possibly come from a horizon a little older than Irdin Manha, although this is not probable.

MEASUREMENTS OF *Desmatotherium grangeri*

P^2-P^4		= 25.5 mm
P^2	antero-post.	= 8
P^2	transverse	= 9
P^3	antero-post.	= 8.5
P^3	transverse	= 11
P^4	antero-post.	= 9.
P^4	transverse	= 12.

Although the specimens of titanotheres are not so perfectly preserved, yet the associated discovery of *Desmatotherium* in Korea surely proves a close connection of mammalian faunas in Korea and Mongolia in Upper Eocene time.

By means of the above-mentioned data we can say that the Hozan horizon, of Korea belongs to the Upper Eocene and is probably correlated with either the Irdin Manha or Shara Murun formations of Mongolia.

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BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. XXIV¹

NOTES ON POLYNESIAN FLYCATCHERS AND A REVISION OF THE GENUS *CLYTORHYNCHUS* ELLIOT

By ERNST MAYR

The confusion among the Polynesian flycatchers has made urgent the need for a revision. The present classification is very artificial, especially as the main character on which the classification is based, the shape of the bill, is not only different in every genus, but even varies sometimes in the races of the same species.

There are a few fairly circumscribed genera of flycatchers that extend into Polynesia, as *Rhipidura*² and *Myiagra*. Other species agree in general color pattern, in the structure of the plumage, in the shape of the wing, in the structure of tarsus and feet, and other characters, but show many peculiarities in the shape of the bill. While the ordinary flycatcher bill is depressed, these birds have a bill that is as high as it is wide, or even decidedly compressed. This variation is deceptive enough to have caused the birds to be arranged in entirely different families, as, for example, in the Prionopidae or Laniidae. I called attention to this in my paper on the birds of Rennell Island,³ p. 24, stating: "*Pinarolestes* is not a genus of shrikes, as we find it placed in most modern reviews and catalogues, but it is most closely related to two genera of flycatchers, *Monarcha* and *Pomarea*."

Still more striking than the removal of *Pinarolestes* (correctly *Clytorhynchus*) from the shrikes, is another discovery I made during these studies. I found that "*Lalage*" (= *Neolalage*) *banksiana* is not a cuckoo-shrike at all, but a flycatcher, which agrees rather well in its structure with *Mayrornis* except for the different color pattern and stronger feet.

The genera *Pomarea*, *Metabolus* (of which *Monarchares* Mathews is probably a synonym), *Mayrornis*, and *Neolalage* are all more or less closely related to *Monarcha*, and it would be somewhat difficult to

¹Previous papers in this series comprise American Museum Novitates Nos. 115, 124, 140, 322, 337, 350, 356, 361, 365, 370, 419, 469, 486, 488, 489, 502, 504, 516, 520, 522, 531, 590, and 609.

²1931, Amer. Mus. Novit., No. 502.

³1931, Amer. Mus. Novit., No. 490, p. 24.

work out any definite generic characters. They all have a bill that is rather narrow for a flycatcher, but still is usually as broad as high at the nostrils.

When discussing the members of the genus *Pomarea*,¹ Murphy and Mathews did not mention *P. dimidiata* (Hartlaub and Finsch) from the Cook Islands, southwest of Tahiti. Hartlaub and Finsch emphasized the similarity of the new bird to "*Monarches*" [= *Pomarea*] *niger*, and their description agrees well with this viewpoint.

I have examined most of the known specimens of this species in the museums of Bremen, Hamburg, and London, and I fully agree with Hartlaub and Finsch. Mr. Delacour, with whom I inspected the specimens in the British Museum, even suggested that *dimidiata* be regarded as a subspecies of *nigra*. The color characters are undoubtedly essentially the same, but the bill is somewhat longer and flatter than in *nigra*. The genus *Rorotonga* Mathews,² based on *M. dimidiata* Hartlaub and Finsch, therefore has to be considered as a synonym of *Pomarea*.

A specialization occurs in the genus *Clytorhynchus*. The bill is compressed laterally, has a hook, and reaches an enormous size in the larger species of the genus. Nevertheless, a close study soon convinces one that it is really quite a near relative of *Mayornis* and *Pomarea*.

It may be well to mention in this connection that neither does the genus *Pachycephala* belong to the shrikes. The exact position of this genus is doubtful, but, together with some of the related genera, it seems to belong in the vicinity of the flycatchers. As a matter of fact, there are several species in the Papuan region that have been united with *Pachycephala* by some authors and with *Poecilodryas* by others. There is certainly no sharp line.

Two more of the Polynesian genera are referred to the flycatchers, but they belong to different sections of that family. *Gerygone* has already been treated in American Museum Novitates No. 486, 1931, pp. 22-23, and *Petroica*, which occurs in Polynesia with only one species, will be reviewed in a paper which I will prepare soon. The present paper contains a revision of the genus *Clytorhynchus* Elliot. The genera *Myiagra*, *Mayornis*, *Neolalage* and *Petroica* remain to be treated in the future.

CLYTORHYNCHUS Elliot

Clytorhynchus ELLIOT, 1870, Proc. Zool. Soc. Lond., p. 242. Type (by monotypy): *C. pachycephaloides* Elliot.

¹Murphy and Mathews, 1928, Amer. Mus. Novit., No. 387, pp. 1-9.

²Mathews, 1925, Bull. Brit. Orn. Club, XLV, p. 93.

Pinarolestes SHARPE, 1877, 'Cat Birds Brit Mus,' III, p 293. Type (by original designation): *Myiolestes vitiensis* Hartlaub

GENERIC CHARACTERS—A flycatcher of the *Pomarea*, *Chasiempis*, *Mayornis*, and *Monarcha* group, but differs in the large, elongated and laterally much compressed bill; tarsi long and strong; tail long; longest secondary usually longer than second primary; feathers on forehead dense and somewhat stiff; usually no sexual dimorphism in coloration.

The classification of this group has not made much progress since the publication of the 'Catalogue of the Birds in the British Museum,' III (1877). In that publication Sharpe, basing his work partly on earlier authors, confused the classification of the genus so completely that it has not yet been clarified.

To mention first the generic problem, Sharpe included the Papuan *megarhynchus* (and allies) and the Polynesian *vitiensis* (and allies) in one genus. For this genus he created a new name (*Pinarolestes*), assuming that Bonaparte's *Myiolestes* was preoccupied by Cabanis's genus of the same name. But as I have shown recently,¹ Bonaparte's name has at least ten months' priority. Sharpe complicated matters further by selecting *vitiensis* as the type for the "renamed" Bonapartian genus, although none of the Polynesian species was originally included in Bonaparte's genus. He furthermore overlooked (as did every subsequent author) the fact that *vitiensis*, the type species of his new genus *Pinarolestes* (1877) is a geographical representative of *pachycephaloides*, the type species of Elliot's genus *Clytorhynchus* (1870), which Sharpe treated in the eighth volume of the 'Catalogue of Birds.' His genus therefore becomes a synonym of Elliot's, while the Papuan birds, which are generically different, have to be put in the genus *Myiolestes* Bonaparte (1850) [*nec* Cabanis, 1851].

Concerning the specific classification, Sharpe tried (*ibid.*, III, pp. 299-302) to use subspecies against his usual principles, but he had very doubtful success. He divided the Polynesian members of his genus "*Pinarolestes*" into four species: *P. heinei*, *P. vitiensis* (with *buensis*, *fortunae*, and *compressirostris* as subspecies), *P. macrorhynchus* (with *maximus* as subspecies), and *P. nigrogularis*. In fact *heinei* and *macrorhynchus* are subspecies of *vitiensis*, while *maximus* is a synonym of *nigrogularis*. The other *Clytorhynchus* (*pachycephaloides*) he attributed to a different family and treated it in another volume (VIII) of the 'Catalogue of Birds in the British Museum.'

Wiglesworth ('Aves Polynesiæ,' p 27) did not improve on this system except by putting *pachycephaloides* in the vicinity of *vitiensis*,

¹1931 (Dec.), Mitt. Zool. Mus. Berlin, XVII, p 675

following the lead of Layard. Wetmore (Ibis, 1925, pp. 850-851) also did not suggest any improvements, apparently on account of insufficient material. Mathews ('Syst. Av. Austr.', pp. 649-650), who had examined the material of the Whitney Expedition, the same material I have before me, correctly included *heinei*, *powelli*, and *nesiotes* in the species *vitensis*, but otherwise copied the errors of his predecessors.

The Whitney material shows clearly that we have two groups of species in this genus: one with large birds and one with small ones. I shall begin with the treatment of the small forms, since the typical species of the genus belongs to this group.

SUPERSPECIES *Clytorhynchus vitensis*

RANGE.—Southern Melanesia and Central Polynesia. Includes two species: *pachycephaloides* (Southern Melanesia) and *vitensis* (Central Polynesia).

Clytorhynchus pachycephaloides

RANGE —New Caledonia, New Hebrides, Banks and Torres Islands.

***Clytorhynchus pachycephaloides pachycephaloides* Elliot**

Clytorhynchus pachycephaloides ELLIOT, 1870, Proc Zool. Soc. Lond., p. 242, New Caledonia.

TYPE.—No. 7672, Amer Mus Nat Hist; ♂ ad.; New Caledonia.

MEASUREMENTS OF TYPE—Wing, 88.5; tail, 80; tarsus, 21; culmen, 24; exposed culmen, 19.

RANGE.—New Caledonia.

The type is in rather poor condition and so foxed that the color can no longer be described with accuracy. The tips of the wing-feathers and tail-feathers are worn off; the small white tip on the second tail-feather (next to the central) is not visible. The measurements given by Elliot in the original description are somewhat too small, a point which has been stressed by several authors.¹ On the other hand, the measurements given by Layard² are obviously too large. I have given therefore the correct measurements.

Aside from its somewhat larger bill, this bird is surprisingly similar to *vitensis*, and it may be of interest to repeat what Layard said about this bird fifty years ago.³ "It is exactly like a *Myiolestes* in shape and coloration, and, but for the bill, would be taken for one when in the hand. Mr. Cookerell, the zoological collector, now here on his way to

¹All the measurements were compiled by Sarasin, 1913, 'Ogel Neu-Caledoniens,' p. 32.

²1879, Ibis, pp. 110, 111.

³1879, Ibis, pp. 110, 111.

the Solomon Islands, on being shown this bird by us exclaimed, 'Why, I shot that in Fiji!' He was thinking of *Myiolestes vitiensis*."

***Clytorhynchus pachycephaloides griseescens* Sharpe**

Clytorhynchus griseescens SHARPE, 1899, Bull. Brit. Orn. Club, X, p. 29, Espiritu Santo, New Hebrides (type examined)

Clytorhynchus vatensis SHARPE, 1899, *ibid.* p. 29, "Vaté" = Efate (type examined).

ADULT (male and female).—Similar to *pachycephaloides*, but less rufous, more olive on the upperside, and more grayish underneath. Upperside dark brown, with a slight olive tinge (near mummy brown, R. XV), lighter on forehead, and more rufous on rump and upper tail-coverts; underside much lighter and somewhat tending toward a gray color; throat dull buffy gray, slightly streaked by having dark gray shaft-streaks on all feathers of the upper throat; sides of head, ear-coverts, and rest of underside dull grayish clay-color; sides of breast and flanks washed with cinnamon or rufous cinnamon; under tail-coverts with broad white edges as in *pachycephaloides*; tail-feathers fuscous, edged with olivaceous brown near the base; shafts black, underneath white; white tips of decreasing size on all but the central pair of tail-feathers; wings blackish brown, with brown or cinnamon-brown edges to the wing-feathers and upper wing-coverts; axillaries whitish, washed with grayish buff; under wing-coverts gray with whitish edges; inner edges of wing-feathers buff.

IMMATURE (male and female).—Similar to adult, but bill not bluish lead-gray with whitish edges, but blackish brown; wing-feathers more rounded, softer and with more conspicuous brown edges; tail-feathers narrower and more pointed.

NESTLING (juvenile).—Entire body covered with a soft down which is dull rufous-brown on the upperside, and dull grayish drab underneath; the middle of the belly is whitish.

Tarsus 22-23; culmen, from base 24-25.

		WING	TAIL
Efate	12 ♂ ad.	92-97 (94.4)	78-87 (81.5)
Mai	6 ♂ ad.	90-94 (92.3)	79-83 (81.2)
	2 ♀ ad.	90, 90	80, 80
Epi	12 ♂ ad.	91-97 (93.2)	79-86 (81.3)
	5 ♀ ad.	89-93 (90.6)	76-81 (78.2)
Santo	11 ♂ ad.	89-94 (91.8)	75-81 (77.6)
	8 ♂ im.	84-88 (86.3)	75-79 (77.1)
	6 ♀ ad.	88-90 (89.0)	74-77 (75.8)
	5 ♀ im.	84-86 (85.4)	75-77 (76.1)
Vanua Lava	5 ♂ ad.	91-94 (92.4)	76-81 (78.6)
	5 ♀ ad.	87-91 (89.0)	74-78 (75.5)
Hiu, Torres	9 ♂ ad.	88-94 (91.0)	77-81 (79.6)

RANGE.—New Hebrides (Efate, Mai, Pauuma, Lopevi, Aoba, Epi, Aurora, Pentecost, Malekula, Malo and Santo), Banks Islands (Vanua Lava, Meralav, Gaua, Valua, and Bligh), and Torres Islands (Hiu).

There is a great deal of individual variation; some specimens are duller and more sand-colored, others richer and more rufous. Possibly

there is also a slight geographical variation. Sharpe named the bird from Efate from one specimen, stating that "it appears to be slightly different" from the New Caledonian species. Undoubtedly it is! But Sharpe does not give any differences between it and the Santo bird. The extensive material at hand shows that there are no such differences. The Whitney series from Santo is rather dull and sandy colored, but all the specimens are extremely worn. Birds from the Banks Islands and even of the Torres Islands are as richly colored as those from Efate. The Torres Island series agrees very well with birds from other localities, except that most specimens have cheeks, lores, and forehead unusually grayish. In size the birds from the various islands also agree very well with each other. On the average birds from Efate are somewhat larger, but there is a decided overlapping.

Clytorhynchus vitiensis

RANGE.—Fiji Islands, Rotumah, Horne Islands, Samoa, and Tonga group.

Part of this range is inhabited by some quite pronounced subspecies. In the Fiji Islands, however, it is rather difficult to work out subspecies that are well defined and geographically restricted. The few distinguishing characters that are present in this species, such as the shape of the bill, the extent of the white on the tips of the tail-feathers, the proportions, and the general coloration, not only vary individually a great deal but also change slightly from island to island.

One can distinguish four extremes on the four corners of the range of this species within Fiji: Kandavu (S.W.), Viti Levu (N.W.), Taviuni (N.E.), and Lau Archipelago (S.E.), but the birds from all the other islands combine characters of all these four races. It is somewhat a matter of opinion to which subspecies the populations of some of the islands should be referred, and also whether or not additional races should be described from intermediate localities.

Layard and other authors have frequently mentioned the great differences in size between birds from several islands of the Fiji group. The following table of most carefully taken measurements will show that these differences are not very striking and also that the extremes are well bridged by populations from intermediate localities.

Measurements of Adult Males

		WING	TAIL	CULMEN
Kandavu	8 ♂	82-90 (86.6)	67-77 (72.6)	22.3-24.8 (23.2)
Ono	2 ♂	83, 87 (85.0)	70, 74 (72.0)	24.0, 24.4 (24.2)
Mbengha	7 ♂	86-90 (87.7)	74-78 (75.5)	22.0-22.9 (22.3)
Viti Levu	9 ♂	87-94 (90.5)	75-81 (78.4)	22.6-24.2 (23.3)
Ovalau	5 ♂	88-90 (88.8)	76-78 (77.0)	21.3-22.3 (22.0)
Wakaya	1 ♂	86	74	
Makongai	1 ♂	90	78	22.8
Namena	5 ♂	86-91 (89.0)	74-77 (75.0)	21.7-24.0 (23.2)
Ngau	11 ♂	84-88 (85.7)	72-75 (73.5)	22.1-23.7 (22.8)
Koro	11 ♂	85-90 (87.4)	71-76 (74.0)	21.1-23.9 (22.6)
Vanua Levu	10 ♂	89-94 (91.2)	76-83 (79.1)	22.6-24.3 (23.4)
Kio	3 ♂	88, 92 (89.3)	74-79 (77.0)	23.1-23.9 (23.5)
Taviuni	11 ♂	89-95 (92.1)	76-80 (78.0)	23.3-25.8 (24.2)
Rambi	5 ♂	90-93 (91.6)	79-84 (80.8)	23.9-25.1 (24.4)
Ngamia	4 ♂	94-96 (95.2)	79-82 (80.5)	24.9-25.3 (25.1)

Measurements of Adult Females

		WING	TAIL	CULMEN
Kandavu	5 ♀	81-85 (83.4)	68-74 (71.6)	21.5-23.9 (23.1)
Ono	2 ♀	81, 83 (82.0)	70, 70 (70.0)	21.4, 22.8 (22.1)
Mbengha	5 ♀	84-86 (85.0)	74-75 (74.2)	22.1-22.8 (22.4)
Viti Levu	5 ♀	86-89 (87.0)	75-80 (76.6)	22.3-24.0 (23.1)
Ovalau	4 ♀	84-86 (85.0)	73-75 (74.5)	21.7-22.2 (22.0)
Wakaya	2 ♀	84, 86 (85.0)	74, 76 (75.0)	22.0-22.9 (22.4)
Makongai	2 ♀	85, 85 (85.0)	72, 72 (72.0)	21.6, 22.4 (22.0)
Namena	4 ♀	85-89 (87.0)	72-78 (75.2)	21.2-22.9 (22.2)
Ngau	6 ♀	84-87 (85.5)	72-77 (74.2)	21.8-23.1 (22.4)
Koro	4 ♀	84-87 (85.8)	71-74 (72.5)	22.4-23.8 (23.0)
Vanua Levu	4 ♀	85-90 (88.0)	74-78 (75.8)	22.8-24.0 (23.4)
Kio	2 ♀	87, 89 (88.0)	73, 79 (76.0)	23.9, 24.9 (23.4)
Taviuni	5 ♀	85-91 (88.4)	74-76 (75.0)	23.4-24.8 (23.7)
Rambi	2 ♀	84, 89 (86.5)	75, 77 (76.0)	24.0, 24.7 (24.4)
Ngamia	2 ♀	91, 92 (91.5)	79, 80 (79.5)	

Clytorhynchus vitiensis vitiensis (Hartlaub)

Myiolestes vitiensis HARTLAUB, 1866, Ibis, p. 173, Ovalau

ADULT MALE.—Crown, back, and scapulars sepia brown, rump and upper tail-coverts more rufous; lores, superciliaries, and sides of head dull brownish-gray; underside more or less dirty buffy or olivaceous gray, middle of abdomen lighter; sides of throat and breast washed with olive-brown; flanks tawny; wings dark brown, upper wing-coverts and wing-feathers narrowly edged with rufous or cinnamon-brown; axillaries and under wing-coverts gray with a slight brownish wash; tail dark brown, tail-feathers with narrow cinnamon edges near the base; outer three tail-feathers with broad white or buffy white spots on the tip of the inner web; on the outermost tail-feather also some white on the tip of the outer web; size and color of these spots vary considerably.

ADULT FEMALE.—Not perceptibly different from males; white spots on tip of tail-feathers perhaps averaging smaller.

Iris brown, bill black with whitish tomia, feet bluish gray.

IMMATURE.—In coloration similar to the adult, but bill entirely blackish; first primary rounded; wing-feathers softer; tail-feathers narrower

NESTLING.—Body plumage very soft and downy; upperside rufous-brownish, underside whitish, more cinnamomeous on the sides of the breast and flanks; bill black.

MEASUREMENTS.—See table, p 7.

To *vitiensis* I refer also the populations of some of the islands in the vicinity of Ovalau. However, as they have in each case certain characters of their own, I shall describe separately the populations of each of these islands as compared with Ovalau birds.

VITI LEVU.—Slightly larger, with longer bills; tips of tail-feathers on the average purer white; upper throat, lores and sides of head darker, black bases of the feathers more pronounced; upperside less rufous; hind neck and crown with a more distinct grayish olive tinge

WAKAYA AND MAKONGAI.—The few specimens from these two islands agree in every respect with typical *vitiensis*

NAMENA.—Agree in size and coloration very well with Viti Levu specimens; tail short. In some specimens the olive-gray tinge of hind neck and crown is rather pronounced, thus slightly approaching *buensis*

KORO.—Also very similar to typical birds; upperside slightly more grayish olive; ear-coverts lighter and less brownish; under tail-coverts paler, less rufous; tips of tail-feathers more whitish; bill slightly heavier

NGAU.—Smaller than *vitiensis*, particularly in the male sex; bill finer, more compressed; upperside lighter, less dark brown, more cinnamon, less rufous; tail-feathers and wing-feathers lighter brown; grayish parts of underside washed with olive-buff; middle of belly not as light as in *vitiensis*; rufous of flanks and under tail-coverts less tawny, more cinnamon; sides of head lighter; whitish edge of mandibles broader. These birds thus tend in several respects toward the characters of *compressirostris*, but are still clearly referable to *vitiensis*.

MBENGHA.—Somewhat intermediate between *vitiensis* and *compressirostris*, but nearer to *vitiensis*; differs from Ovalau birds in smaller size; bill of a shape similar to *vitiensis*, not long and compressed; upperside dark as in *vitiensis*, sometimes with a dark rufous wash; underside also sometimes rather washed with rufous, but in the series more like *vitiensis* without the buffy tone of *compressirostris*. Remarkable in this population is the high number of specimens in the rufous phase, which occurs only rarely on other islands.

RANGE.—Ovalau, Viti Levu, Namena, Wakaya, Makongai, Koro, Ngu, and Mbengha, Fiji Islands.

Glytorhynchus vitiensis compressirostris (Layard)

yoolestes compressirostris LAYARD, 1876, *Ibis*, p. 153, Kandavu Island (*ibid.*, p. 392).

SUBSPECIFIC CHARACTERS—Similar to *vitiensis*, but smaller; bill longer and much more compressed laterally; whitish edges of tomtia much broader; gonys more or less whitish; underade less grayish, distinctly washed with buff, lower belly not so light; flanks and under tail-coverts lighter tawny; sides of head, throat, and breast lighter; upperside distinctly lighter; back, rump, and upper tail-coverts much more brightly rufous, distinctly different from crown and hind neck; wings and tail not so deep brown, much more rufous; edges of wing-feathers and tail-feathers tawny or rufous; whitish tips on the tail-feathers large and very distinctly washed with rufous, never as pure whitish as in some specimens of *vitiensis*.

IMMATURE PLUMAGE.—One immature male from Vanuakula has the bill entirely black and has other characters of immaturity; upperside darker, with less rufous in the plumage; underside clearer, less buffy.

MEASUREMENTS.—See table, p 7.

RANGE.—Kandavu, Ono, Vanuakula, Fiji Islands.

Birds from Ono agree perfectly with Kandavu birds. No adult was collected on Vanuakula.

Clytorhynchus vitiensis buensis (Layard)

M [yloestes] buensis LAYARD, 1876, Ibis, p. 145, Mbua Bay, Vanua Levu, Fiji.

SUBSPECIFIC CHARACTERS—Similar to *vitiensis*, but slightly larger, with a heavier bill; underside less grayish, somewhat washed with olive-buff; rufous flanks less conspicuous, under tail-coverts less rufous; upperside very different, much lighter and with a grayish olive, not brownish rufous, tinge; lores, sides of head, ear-coverts, and sides of neck much lighter, more grayish, less brownish; wings and tail on the average lighter, tending more to grayish cinnamon than to rufous brown; whitish tips of tail-feathers large as in *vitiensis*, sometimes strongly washed with rufous

MEASUREMENTS.—See table, p 7

RANGE.—Vanua Levu and Kio Islands, Fiji Islands.

Birds from Kio Island agree very well with Vanua Levu birds.

There is no specimen in the British Museum that can be considered the actual type of this form; however, there is a series of six specimens from Bua Bay identified as *buensis* by Layard himself. These specimens are probably the cotypes of *buensis*. The measurements given by Layard in his original description are obviously wrong, as are most of Layard's measurements; he gives for the wing 82 mm., for the tail 84, for the bill 27.5, and for the tarsus 23 (Ibis, 1876, p. 146). This is too large for tail, bill, and tarsus, and too small for the wing. However, the name *buensis* cannot be referred to *nigrogularis*, since all the specimens in the British Museum that were referred by Layard to *buensis* belong to the smaller species (*vitiensis*). The name *buensis* will have to be applied therefore to the geographical representative of *vitiensis* on Vanua Levu.

Clytorhynchus vitiensis layardi, new subspecies

TYPE.—No. 252357, Amer. Mus. Nat. Hist.; ♂ ad.; Tavuni Island, Fiji Islands; December 13, 1924; R. H. Beck and J. G. Correia.

?*Pachycephala macrorhyncha* LAYARD, 1875, Proc Zool Soc. Lond, p. 150, Taviuni, preoccupied by *Pachycephala macrorhyncha* Strickland, 1849

?*Myiolestes macrorhynchus* LAYARD, 1876, Ibis, p. 145 (new combination).

SUBSPECIFIC CHARACTERS.—Similar to *buensis* Layard, but slightly larger and with stronger bill; underside very different, strongly washed olivaceous ochre or buff; middle of abdomen not distinctly whitish; tawny sides of breast and flanks not so strongly contrasting with the rest of the under surface; under tail-coverts tawny; upper surface rather bright and rufous, resembling that of *compressirostris*, not as dull brownish as in *vitensis*, or as grayish olive as in *buensis*, lower back and rump strongly rufous, crown and nape with a slight olive tinge; ear-coverts, sides of head, and of throat with a warm brown tinge, not as grayish as in *buensis* or as dull brown as in *vitensis*, wings and tail strongly washed with rufous brown; tips of tail-feathers buffy to rufous, small and not always very pronounced; sometimes only indicated as a lighter apical zone of the tail-feathers

MEASUREMENTS.—See Table, p. 7.

RANGE.—TAVIUNI Island, Fiji.

The nomenclature of this subspecies has been in a great muddle up to date. In 1875 (Proc Zool. Soc. Lond, p. 150) Layard described a *Pachycephala macrorhyncha* from Taviuni Island, which he called *Myiolestes macrorhynchus* in the following year (Ibis, 1876, p. 145). This name was applied to the larger species of *Clytorhynchus* by most of the subsequent authors (Sharpe, Wigglesworth, Wetmore, and Mathews). The type apparently is no longer in existence, and we have to rely on Layard's description for an identification. The color characters he gives (in 1875 and 1876) apply fairly well to *layardi*, but his measurements are rather confused, as can be seen from the following transcription of his inches and lines into millimeters.

	WING	TAIL	BILL	TARSUS
<i>layardi</i> , Whitney Series ♂ and ♀	85-95	74-80	23.3-25.8	20.0-21
<i>macrorhynchus</i> (P. Z. S., 1875)	89	76	25.4	21.0
<i>macrorhynchus</i> (Ibis, 1876)	84	95	29.6	27.5

The measurements given in 1875 fit *layardi* well, but the different measurements given in 1876 for the same form (sic!) are obviously impossible, since in no form of *Clytorhynchus* is the tail longer than the wing. Layard's remark (Ibis, 1876, p. 146): "The bills of *M. buensis* and *M. macrorhynchus* much exceed the others [*vitensis* and allies] in length, and are nearly twice as thick" was probably the principal reason why many subsequent authors associated *macrorhynchus* with *maximus* (= *magrogularis*). Layard, however, calls his newly discovered form *maximus* (Ibis, 1876, p. 153) "the giant of the genus, far exceeding *M. macrorhynchus* in size; its bill is the chief feature." By this statement he puts *macrorhynchus* rather definitely among the smaller species of *Cly-*

torhynchus. A series of birds in the British Museum, labeled *M. macrorhynchus* by Layard himself, consists of birds of the smaller species. It is therefore probable that most of the recent ornithologists were mistaken in referring the name *macrorhynchus* to a representative of the larger species.

The name *macrorhynchus* is preoccupied and could not be used any more even if it could be definitely associated with one of the Fijian forms of *Clytorhynchus*. The identity of *macrorhyncha* Layard, however, can not be assured with certainty, as the type is lost, although I have shown in the previous discussion that it refers most likely to the smaller species. In the face of this situation it seems wiser not to rename *macrorhynchus* Layard but simply to describe as a new subspecies the geographical representative of *vitensis* on Taviuni and to refer to it as doubtful synonym *Pachycephala macrorhyncha* Layard (*nec* Strickland).

The smaller islands of eastern Fiji are inhabited by a series of subspecies which form a complete bridge between *vitensis* and *buensis* of the western Fiji islands, and *heinei* of the Tonga group.

The first step in this direction is *pontifex* which already has practically the large size of *heinei*, but in coloration is still similar to *buensis*. The next step is *valuana*, which has the underside much lighter and purer gray than any bird in the western Fijis; *nesioles* combines this with a reduction of the rufous tones on the upperside; the final step in this direction is *heinei*, in which form the brownish colors in the plumage are almost entirely eliminated.

***Clytorhynchus vitensis pontifex*, new subspecies**

TYPE.—No. 252318, Amer Mus. Nat Hist; ♂ ad; Ngamia Island, Fiji Islands; Nov. 25, 1924; R H Beck and J G Correia.

SUBSPECIFIC CHARACTERS.—Similar to *buensis*, but much larger and with stronger bill (see measurements) underside purer gray, less washed with buff; under tail-coverts lighter; tips of tail-feathers more rarely washed with rufous, usually more whitish; upperside similar to that of *buensis*.

		WING	TAIL	CULMEN
Ngamia	4 ♂ ad	94-96 (95.2)	79-82 (80.5)	24.9-25.3 (25.1)
	2 ♀ ad.	91, 92	79, 80	
	1 ♀ imm	91	78	24.6
Rambi	4 ♂ ad	91-93 (92.0)	79-84 (80.5)	23.9-24.8 (24.2)
	2 ♂ imm	85, 90	79, 82	23.6, 25.1
	2 ♀ ad.	84, 89	75, 77	24.0, 24.7

RANGE.—Ngamia and Rambi Island, Fiji Islands.

It is with some hesitation that I include the Rambi birds in the range of *pontifex*. They have rather strong bills and also have the under surface

rather grayish, but they are of the general size of *buensis* and *tamunensis*, and have the upperside more rufous brown than either. If one does not want to create a new form on these slight characters, it seems to be best to include these birds with *pontifex*.

***Clytorhynchus vitiensis vatuana*, new subspecies**

TYPE.—No. 252270, Amer. Mus Nat Hist; ♂ ad; Tuvutha Island, Fiji Islands; September 10, 1924; R. H. Beck and J. G. Correia.

SUBSPECIFIC CHARACTERS.—In size and coloration of the underparts very similar to *nesiotes*; however, chin, throat, breast, and sides of throat lighter and less pure gray; under tail-coverts darker buff; forehead, lores, and chin less blackish; upperside very different, much lighter; on crown and hind neck tending to olivaceous cinnamon; back, rump, and upper tail-coverts brighter rufous, not so dull brown; edges of wing-feathers and tail-feathers brighter and more rufous; differs from *pontifex* by the grayish underside which is hardly washed with any buff, by having the tips on the tail-feathers pure white and much smaller; approaching *pontifex* in the coloration of the upperparts.

		WING	TAIL	CULMEN
Tuvutha	9 ♂ ad	99-102 (100.7)	78-84 (82 3)	24.6-26.2 (25.5)
	1 ♀ ad	96	82	24.7
Yathata	5 ♂ ad	94-100 (96.4)	75-85 (80.4)	24.1-25.6 (24.9)
	3 ♀ ad	93, 95, 97	78, 80, 81	23.0, 23.9, 24.2
Vatu Vara	1 ♂ ad	95	79	24.8
	2 ♀ ad	95, 95	79, 79	23.8, 24.1

RANGE.—Northern Lau Archipelago (Tuvutha, Yathata, and Vatu Vara), Fiji Islands.

The birds from Yathata and Vatu Vara can be referred to *vatuana*, although they show some minor differences. They are slightly smaller, and particularly the Vatu Vara specimens show less rufous, more olivaceous cinnamon on the upperside. They agree, however, in the coloration of the underparts and in the bright (not dull as in *nesiotes*) coloration of the upper surface.

***Clytorhynchus vitiensis nesiotes* (Wetmore)**

Pinarolestes nesiotes WETMORE, 1919, Bull. Mus. Comp. Zool., LXIII, p. 216, Kambara, Lau Archipelago, Fiji Islands.

SUBSPECIFIC CHARACTERS.—See original description, and see above, under *vatuana*, and below under *heinei*, p. 13.

		WING	TAIL	CULMEN
Kambara	11 ♂ ad.	96-102 (99.3)	75-81 (78.9)	24.6-26.6 (25.3)
	10 ♀ ad.	95-100 (97.8)	76-81 (79.1)	24.2-27.1 (25.3)
Wangava	2 ♂ ad.	98, 104 (101.0)	82, 85 (83.5)	26.1, 26.7 (26.4)
	3 ♀ ad.	97, 98, 100	79, 80, 80	25.7, 25.8, 25.9
Fulanga	2 ♂ ad.	102, 103 (102.5)	80, 80 (80.0)	25.9, 27.1 (26.5)
	1 ♀ ad.	101	81	26.1
Ongea Levu	9 ♂ ad.	99-103 (100.3)	79-85 (82.6)	24.2-26.0 (25.3)
	11 ♀ ad.	95-100 (97.8)	76-83 (80.2)	24.7-26.7 (25.5)
Yangasa Cluster	3 ♂ ad.	102, 104, 105	82, 85, 85	24.4, 24.7, 25.8
	3 ♀ ad.	97, 99, 99	80, 81, 83	23.6, 23.7, 25.8
Namuka ilau	6 ♂ ad.	97-101 (98.8)	79-81 (79.8)	25.1-25.9 (25.4)
	5 ♀ ad.	94-99 (96.2)	76-81 (78.7)	24.8-25.8 (25.3)
Oneata	1 ♂ ad.	102	80	25.3
	1 ♀ ad.	99	83	24.8
Aiwa	4 ♂ ad.	96-103 (100.0)	80-83 (81.5)	25.3-26.6 (25.9)
	4 ♀ ad.	95-99 (96.5)	75-78 (76.5)	23.6-25.0 (24.4)

Tarsus, 23-24; exposed culmen, 21-22 mm

RANGE.—Southern Lau Archipelago (Wangava, Kambara, Fulanga, Ongea Levu, Yangasa Cluster, Namuka ilau, Oneata, and Aiwa).

Birds within this range are very uniformly colored. The size, however, varies somewhat from island to island.

Wetmore, in his original description, compared this bird with *vitensis* and *compressirostris* from the Fiji Islands. It is, however, really nearer to *heinei* from Tonga and forms a perfect link between *vitensis* and *heinei*.

Clytorhynchus vitensis heinei (Finsch and Hartlaub)

Myiolestes heinei FINSCH AND HARTLAUB, 1869, Proc. Zool. Soc. Lond., p. 546, Tonga Islands.

DESCRIPTION.—Crown, back, and scapulars fuscous brown, lower back and rump of a warmer brown; lores, cheeks and feathers around the eye dark, almost blackish; ear-coverts dull brownish-gray; underside gray, darker on the breast, lighter, almost white in the middle of the abdomen; flanks dull grayish-cinnamon; thighs gray; wings fuscous brown, edges of the primaries dull grayish-brown, of the secondaries and wing-coverts cinnamon; axillaries and under wing-coverts light gray; upper tail-coverts grayish brown or of the color of the rump; under tail-coverts whitish or light buffy with the bases of the feathers grayish; tail fuscous, large white tips (outer and inner web) on the three outer tail-feathers (VI-IV), small tip on III, very small tip on II (sometimes missing) and no tip on the central part of tail-feathers.

Bill blackish with broad whitish edges on maxilla and mandible; tip of mandible also extensively whitish

Differs from *nesiotae* by smaller wing and bill, by having more white on the bill, by being more grayish, and lighter underneath, and by having much broader white tips on the tail-feathers.

		WING	TAIL	CULMEN
Hongahapai	3 ♂ ad	94, 97, 99	79, 82, 82	23 9, 26 1, 26 7
	3 ♀ ad	92, 93, 94	78, 79, 79	24 9, 26 0, 26 8
Kelelesua	8 ♂ ad.	93-96 (94 9)	76-82 (78 8)	23 9-25 5 (24 5)
	6 ♀ ad.	91-94 (92 3)	73-80 (76 0)	22 9-25 3 (24 4)
Ofalanga	8 ♂ ad	95-99 (97 4)	77-81 (79 0)	23.2-25 8 (24 6)
	2 ♀ ad	95, 96	75, 78	25.0, 25 0
Kao	10 ♂ ad	95-97 (95 9)	77-82 (79 1)	23 8-25 0 (24.2)
	2 ♀ ad.	91, 92	75, 75	23 2-23 8

Tarsus, 24-25; exposed culmen, 19-21

RANGE.—Central Tonga groups, Namuka group (Kelelesua, Tonumeia, Telekitonga, Lalona, Mango, and Nomuka iki), Hongahapai and Hongatonga, Haapai group (Tongua, Teaubu, Fotuhua, Uanukuhilfu, Uanukuhahaki, Tofanga, Uoleva, Ofolanga), Tofua, and Kao.

It is interesting to note that this species is very plentiful on the central islands of the Tonga group, but is not known from the southern or northern islands.

***Clytorhynchus vitiensis wiglesworthi*, new subspecies**

TYPE.—No 252520, Amer Mus. Nat. Hist; ♂ ad; Rotumah Island; May 18, 1925; J. G. Correia

SUBSPECIFIC CHARACTERS.—Of the general size of *layardi*, but tail on the average shorter; bill as in *layardi*, long and only slightly compressed, white edges of maxilla, and particularly of the mandible very broad, tips of three outermost tail-feathers pure white or very light buff, gradually merging into the gray of the upper part of the tail-feathers; white tips shorter than in *layardi* or *buensis*, underside similar to that of *vitiensis*, rather light with the rufous on flanks and under tail-coverts quite pronounced; upperside very much as in *buensis*, but without the sand-colored tinge in the hind neck, not as dark brownish as in *vitiensis*; lores, circumference of eyes and sides of head very dark, sometimes almost blackish.

	WING	TAIL	CULMEN
10 ♂ ad.	91-96 (94 1)	75-82 (77.6)	23 9-25.0 (24.4)
3 ♀ ad	91-93 (92.0)	74, 75 (74 5)	23 0-23 9 (23 3)

Tarsus, 20-23; exposed culmen, 19-20 mm.

Most birds (collected in May) are in badly worn plumage or molting.

RANGE.—Rotumah Island (260 miles northwest of the Fiji Islands).

I name this new subspecies in honor of the late Lionel W. Wiglesworth, who did so much for a better understanding of Polynesian birds, and who had already called attention to a possible difference of the Rotumah birds ('Aves Polynesiæ,' p. 27).

***Clytorhynchus vitiensis fortunæ* (Layard)**

M. [yolestes] fortunæ E. L. LAYARD, 1876, Ibis, p. 145, Fortuna Island.

SUBSPECIFIC CHARACTERS.—Smallest and lightest form of the species; bill short

and very little compressed laterally; greater part of the mandible and edge of maxilla whitish; tips of tail-feathers entirely white (large on VI-IV, small on III), smaller than in *vitiensis*, sharply defined, not gradually merging into the grayish part of the tail-feathers; upperside rather similar to that of *vatuana*, but forehead, lores, and superciliaries distinctly grayish; crown and hind neck with a distinctly grayish tinge, strongly contrasting with the bright cinnamon lower back; underside lighter and of a clearer gray than in most Fijian races, scarcely washed with buff; upper throat whitish with dark shaft-streaks; middle of belly white, flanks tawny, crissum brownish, and tips of tail-feathers whitish

	WING	TAIL	CULMEN
13 ♂ ad	83-86 (84.8)	67-71 (68.9)	20.0-22.1 (21.1)
8 ♀ ad.	80-85 (82.0)	66-69 (68.1)	20.0-21.0 (20.6)

Tarsus, 20-21; exposed culmen, 16-17 mm.

Most birds are still molting or are freshly molted.

RANGE.—Horne group, Fotuna and Alofa Islands (May, 1925).

Clytorhynchus vitiensis powelli (Salvin)

Pinarolestes powelli SALVIN, 1879, Proc. Zool. Soc. Lond., p. 128, "Tutuila," error for Manua Islands, Samoa

SUBSPECIFIC CHARACTERS.—Very dark, upperside almost blackish; bill medium sized, not much compressed; bill black, narrow edge on maxilla and mandible whitish; tail fuscous, tail-feathers VI-IV with small and well-defined white tips, III with a narrow white edge, and II and I without white markings; upperside fuscous, darkest on crown and hind neck, tinged with cinnamon on lower back, feathers of rump with cinnamon tips; wing blackish brown, wing-coverts narrowly margined with clay-color; wing-feathers edged with olivaceous brown; underside dirty buffy or ochraceous gray (brighter than drab, R. XLVI), flanks more cinnamon, middle of abdomen whitish; feathers of throat sometimes with dark gray shaft-stripes; under tail-coverts grayish with broad buffy edges.

	WING	TAIL	CULMEN
♂ ad.	88-93 (91.3)	73-77 (75.2)	22.8-24.8 (23.9)
♀ ad.	87-90 (88.7)	71-75 (73.0)	23.1-24.2 (23.9)

Tarsus, 24-25; exposed culmen, 17-19 mm.

Most birds are very worn, or have just begun molting.

RANGE.—Manua Islands (Ofu, Olosinga, Tau), Samoa (December, 1923, January, 1924).

In the original description, Salvin gives Tutuila as the type locality. But this species has never been found on that island since then. All the other known specimens have come from the Manua Islands.

I had an opportunity to examine the type in the British Museum and found that the locality indication "Tutuila" was added on the original label in the handwriting of Philip L. Selater (through whom Salvin acquired the collection from Powell). It is fairly obvious that some

mistake occurred about the locality, and that the type specimen actually came from the Manua Islands, like the majority of the Powell collection.

Clytorhynchus vitiensis keppeli, new subspecies

TYPE.—No. 250422, Amer. Mus. Nat. Hist.; ♂ ad; Keppel Island, Pacific Ocean, between Samoa and Tonga; August 26, 1925; R. H. Beck and J. G. Correia.

SUBSPECIFIC CHARACTERS.—Very dark form; bill short and slender, but not as compressed as in *vitiensis*; bill black, narrow edge on maxilla and broad edge on mandible whitish; tail blackish, white tips reduced to narrow white edges on the tips of the two or three outermost tail-feathers; upperside brownish fuscous with a slight olivaceous tinge (near *Chaetura* drab, R. XLVI), lighter and more brownish on lower back and rump, darker, almost blackish, on hind neck and upper back; feathers of forehead edged with pale brown; wings blackish, upper wing-coverts and wing-feathers narrowly edged with olivaceous fuscous; underside grayish (near mouse gray, R. LI), middle of abdomen slightly lighter, flanks washed with brownish; under tail-coverts dark brownish-gray with white tips

	WING	TAIL	CULMEN
♂ ad.	89-82 (90.8)	69-74 (71.4)	21.1-22.7 (21.9)
♀ ad.	86-89 (87.1)	67-72 (69.0)	20.9-22.8 (21.8)

Tarsus, 22-23; exposed culmen, 18-20 mm.

The birds (collected in May) are in rather fresh plumage.

RANGE.—Keppel (Niuatobutabu) and Boscawen (Tafahi). These two islands are frequently included in the Tonga group, but in distance as well as in the zoogeographical aspect they are really closer to the Samoan Islands.

This is the darkest form of the genus. There is no difference between the birds from the two islands

GROUP OF LARGE FORMS

Clytorhynchus nigrogularis

RANGE.—Fiji Islands and Santa Cruz Island

Clytorhynchus nigrogularis nigrogularis (Layard)

Lalage nigrogularis LAYARD, 1875, Proc. Zool. Soc. Lond., p. 149, Levuka, Ovalau Island.

Myiolestes maximus LAYARD, 1876, Ibis, p. 498, Kandavu Island.

ADULT MALE.—(Grayish phase).—Part of forehead, lores, circumocular feathers, narrow superciliaries, chin, cheeks, upper throat, area surrounding white auricular spot, and sides of hind neck black with a slight bluish gloss; ear-coverts, narrow strip above superciliaries and lower edge of the black throat whitish gray; crown and hind neck slaty gray with a slight brownish tinge; back, upper wing-coverts, and edges of wing-feathers dull olivaceous brown with a grayish tinge; rump and upper tail-coverts more grayish; underside light gray, darker on the breast, lighter on the middle

of the abdomen; flanks washed with brownish olive; under tail-coverts with gray or brownish-gray centers and whitish edges; tail brownish, three lateral pairs of tail-feathers with white or buffy tips; axillaries whitish; lesser under wing-coverts blackish, the larger ones grayish; inner edge of wing-feathers whitish or buffy.

Brownish phase.—There is a great deal of individual variation in this species. In some specimens the crown and the underside are strongly washed with brown, and the back may have an almost rufous coloration. Other adult males that wear a female-like plumage are treated with the immature males.

ADULT FEMALE.—Brownish, lighter below; crown and hind neck olive-brown (R. XL), back and scapulars slightly more rufous (Brussels brown, R. III), and rump distinctly so; sides of head light grayish-brown; underside dull buff, lighter on throat and middle of abdomen, darker and more grayish on the sides of the throat and on the breast; middle of lower belly whitish; flanks and under tail-coverts washed with tawny; axillaries, under wing-coverts, and inner edges of wing-feathers buffy; wing brown, feathers with rufous-brown edges; tail olive brown, outer edges near the base cinnamon; tips of outer tail-feathers buffy.

Iris brown; bill black, tip horn-colored; feet bluish gray.

There is some individual variation in the female plumage; some specimens have the upperside much more rufous and the underparts washed with tawny. Some specimens show an approach toward the male plumage. No. 252347 (Taviani) and No. 252547 (Vanua Levu) have a few dull blackish feathers on cheeks and throat, but agree otherwise with females from the same islands. No. 252544 (Viti Levu) and No. 252532 (Ovalau), however, are much more advanced in this respect; the entire upper throat, superciliaries, and auriculars are dull blackish, many feathers with buffy tips; these two birds are also more grayish, less rufous brown, in their general coloration, approaching the males also in this respect. It is possible that one of the two (No. 252532) is a wrongly sexed male. No approach toward the male plumage is shown by any of the four females from Kandavu. This is noteworthy since, in the males from that island, the characters of that sex are also less pronounced than in the males from other islands. There may be a racial difference in this respect between birds from Kandavu and those from the rest of the Fiji group.

IMMATURE MALE (II phase).—Just as in *Pachycephala pectoralis* and certain other species of birds (cf. Amer. Mus. Novit., No. 522, p. 11), there are two phases of plumages in those males that do not wear the fully adult plumage as described above. There are six birds in the collection with large or partly enlarged testes and with the characters of adult birds on wing and tail, which have a plumage similar to that of the female. In three of these there are no blackish feathers on forehead, cheeks, and throat, while they are present in three others. Some males of this species possibly never attain the fully adult plumage; this is particularly probable for birds from Kandavu Island.

IMMATURE FEMALE.—Agrees in general coloration with the adult female, but wing-feathers and upper wing-coverts are softer, alula and first primary more rounded, tail-feathers narrower and more pointed, and tomia of mandibles black except at the tip.

IMMATURE MALE (I phase).—Indistinguishable from the immature female

Measurements of Birds from the Different Islands

	TAVIUNI	VANUA LEVU	VITI LEVU	OVALAU	KANDAVU
WING					
♂ ad	103-105 (103.8)	104-106 (105.5)	104-110 (106.3)		
♂ imm. (II ph.)	100, 102, 105				102, 103, 105
♂ imm. (I ph.)		100, 103			98
♀ ad.	101, 102	98	102, 104		97-103 (99.8)
♀ imm.		98	102	98	
TAIL					
♂ ad	84-85 (84.8)	82-88 (86.2)	85-92 (87.6)		
♂ imm. (II ph.)	83, 83, 87				80, 84, 84
♂ imm. (I ph.)		86			79
♀ ad	83, 83	80, 82	86, 88		79-83 (80.8)
♀ imm.		87	88	85	
CULMEN					
♂ ad.	28.3-30.1 (29.1)	27.5-29.9 (28.8)	27.0-29.2 (28.4)		
♂ imm. (II ph.)	28.1, 27.1, 28.7				26.9, 28.0, 28.8
♂ imm. (I ph.)		26.8, 27.0			29.0
♀ ad.	26.9, 30.0	27.1, 27.2	28.1, 28.8		27.1-29.3 (28.1)
♀ imm.			28.9	28.1	
TARSUS	24-27 (25.5)				

MATERIAL EXAMINED—Taviuni 5 ♂ ad., 3 ♂ semi-ad (II phase), 2 ♀ ad ; Vanua Levu 3 ♂ ad , 2 ♂ imm (I phase), 2 ♀ ad , 1 ♀ imm ; Viti Levu 7 ♂ ad , 2 ♀ ad , 1 ♀ imm ; Ovalau 1 ♂ imm (?), 1 ♀ imm ; Kandavu 3 ♂ semi-ad (II phase), 1 ♂ imm , 4 ♀ ad

RANGE—Larger islands of the Fiji group.

The classification of this species up to the present time has been in a state of great disorder for three reasons: first, the disregard of the strong but not recognized sexual dimorphism; second, the pronounced individual variation; and third, the wrong application of the name *macro-rhynchus* Layard

A short survey of the taxonomic history of this species may help in clearing the doubtful points. The male in the fully adult plumage was described from Levuka, Ovalau, as *Lalage nigrogularis* by Layard (P. Z. S., 1875, p. 149). In the following year Finsch (P. Z. S., 1876, p. 20) pointed out that the genus *Myiolestes* was the proper position for this bird, a classification which was adopted by most of the subsequent writers and also by Sharpe in the 'Catalogue of Birds' (1877, III, p. 301). In 1876, Layard described, from Kandavu, a male in female plumage as *Myiolestes maximus* (Ibis, 1876, p. 498) without any reference to *nigrogularis*, only comparing his "new species" with the smaller species *M. vitiensis* Hartlaub. In 1877, Sharpe, evidently without having seen a specimen of *maximus*, placed it as a subspecies of *macro-rhynchus* which apparently is a subspecies of *vitiensis* (see p. 10). This arrangement was adopted by Wiglesworth ('Aves Polynesiae,' p. 28) and Wetmore (Ibis, 1925, p. 850).

The material of the Whitney Expedition permits me to prove not only that *maximus* is nothing but the female plumage of *nigrogularis*, but also that this species shows no recognizable geographical variation within its Fijian range comprising the five islands, Taviuni, Vanua Levu, Viti Levu, Ovalau, and Kandavu.

Although the material before me contains more specimens of this species than ever were known previously, it is not so rich as I wish it were. There are no fully adult males from Kandavu in the collection, and the series from the other islands also are not so large as desirable for a highly variable species. However, I am able to make the following remarks on the individual and geographical variation.

As described above, the males of this species may occur in a grayish or in a brownish phase, with many intermediates. The following table will illustrate the proportion of the different phases from the different islands.

	BROWNISH	INTERMEDIATE	GRAYISH
Taviuni	1(+3) ¹	3	1
Vanua Levu	2	2	1
Viti Levu		3	4
Kandavu	(2) ¹		

It can be seen from this table that the populations from Taviuni and Vanua Levu have a high percentage of brownish birds, while on Viti Levu we find a majority of grayish specimens. Unfortunately the material from Kandavu is not sufficient to show which phase prevails on that island. Birds not fully adult seem always to belong to the brownish phase.

In the females there is also a slight indication of a brownish and grayish phase. However, we find specimens of both phases about equally distributed on all the islands

***Clytorhynchus nigrogularis sanctaecrucis*, new subspecies**

TYPE.—No 217985a, Amer. Mus. Nat. Hist.; ♂ ad; Santa Cruz Island, Santa Cruz Islands; February 24, 1927; R. H. Beck

ADULT MALE.—Somewhat similar to *nigrogularis*, but very much smaller, lighter, and less grayish; forehead, loreal region, cheeks, upper throat, and posterior edge of ear-coverts glossy black; a few whitish feathers sprinkled in on throat and cheeks (sign of immaturity?); crown, upper back and scapulars dark brown, lower back and rump more rufous; upper tail-coverts mottled blackish and dark rufous brown; auriculars buffy; sides of neck and posterior part of superciliary grayish; lower throat whitish, sides of throat grayish; breast, abdomen, flanks, and under tail-coverts whitish washed with light ochraceous buff; middle of abdomen whitish; axillaries and greater under wing-coverts white or light buff, bend of wing and lesser under wing-coverts blackish; thighs blackish; wings brown, inner primaries and outer secondaries with tawny edges, inner secondaries with blackish margins; upper wing-coverts with black edges, some of the lesser wing-coverts entirely glossy black; tail dark brown, edges of central tail-feathers blackish near the base, outer tail-feathers with narrow buffy tips.

IMMATURE MALE (II phase).—Similar to the adult male, but blackish on the forehead and circumocular region only; no black on throat, wings or thighs; tail and wings more brownish; rufous buffy tips on outer tail-feathers broader

Tarsus, 23 mm

	WING	TAIL	CULMEN
1 ♂ ad	91	72	23 3
1 ♂ im. (II phase)	90	72	24 1

RANGE.—Santa Cruz Island, Santa Cruz Islands.

Unfortunately only two specimens of this very interesting new form were collected. It is very distinct and would probably be regarded as a species by many conservative ornithologists. The bill in the new form is

¹In brackets, not fully adult males.

more than proportionally smaller and decidedly less heavy than in *nigrogularis*. It is less deep and gives an impression of greater slenderness. The color pattern of the two forms, however, is essentially the same. This is more evidence for my statement that in these Polynesian flycatchers the form and proportion of the bill frequently change more than the coloration. The bird, described as adult, has possibly not yet reached the fully adult plumage; a small grayish patch before the eye, a few scattered white feathers on the throat, and the buffy tinge of the ear-coverts seem to indicate this.

***Clytorhynchus hamlini* (Mayr)**

Pinarolestes hamlini MAYR, 1931, Amer. Mus. Novit., No. 486, p. 23, Rennell Island.

RANGE.—Rennell Island.

Description and measurements, see Mayr, *loc. cit.*, pp. 23, 24.

This species is undoubtedly related to *nigrogularis*, but it differs in so many essential characters that it has to be regarded as a good species. Its main differences from *nigrogularis* are: the long and narrow bill, the absence of gray tones in the plumage, the black coloration of the ear-coverts, the brilliant white axillaries and under wing-coverts, the absence of light tips on the tail-feathers, and the differences in the juvenal plumage.

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BRAINCASTS OF TWO TYPOTHERES AND A LITOPTERN¹

BY GEORGE GAYLORD SIMPSON

In the preceding paper of this series (Simpson 1933), the braincasts of *Phenacodus*, *Notostylops*, and *Rhyphodon* were described and illustrated. In this paper this research will be completed, so far as now possible to me, by the description of braincasts of *Hegetotherium*, *Protyopotherium*, and *Proterotherium*, and the general results will be summed up. The introductory remarks and acknowledgments of the previous paper apply equally to this.

Hegetotherium

This braincast is taken from a skull of *Hegetotherium mirabile*, Amer. Mus. No. 9223, found by Barnum Brown in 1899 in the Santa Cruz Formation at Halliday's Estancia, Río Gallegos, Santa Cruz. This fine skull was described and figured by Sinclair, but the braincast was not taken. No Santa Cruz notoungulate braincast has been previously described. The cast is very good, including all the features of the left side and extending beyond the midline.

The total length of the skull is 115 mm. and of the brain (exclusive of medulla) 59 mm., giving an index of 51, slightly greater than in *Notostylops* (about 48). The figures are comparable as the skulls are of nearly the same size and rostral development. If the olfactory bulbs be omitted from the length, the index for *Notostylops* is about 37 and for *Hegetotherium* about 43. Due to the greater flexure and much greater depth of the present brain, its volume is even larger relative to that of *Notostylops*. *Hegetotherium* does seem to represent a real advance over the earlier genus in effective brain size.

The olfactory bulbs remain fully exposed, but the midbrain was surely completely covered dorsally and the cerebrum has even begun definitely to overlap the cerebellum. The arrangement can no longer be called serial, and the flexure is greater than in *Notostylops*. As a whole, the brain is relatively shorter and wider, and also much deeper, especially in the cerebellum. The ratio of the exposed, dorsal parts of olfactory

¹Publications of the Searratt Patagonian Expedition, No. 16.

bulbs, cerebrum, and cerebellum is about 2:7:3, decidedly different from *Notostylops* and expressive of great reduction of the olfactory bulbs, expansion of the cerebrum, and overlapping, shortening, and deepening rather than reduction of the cerebellum.

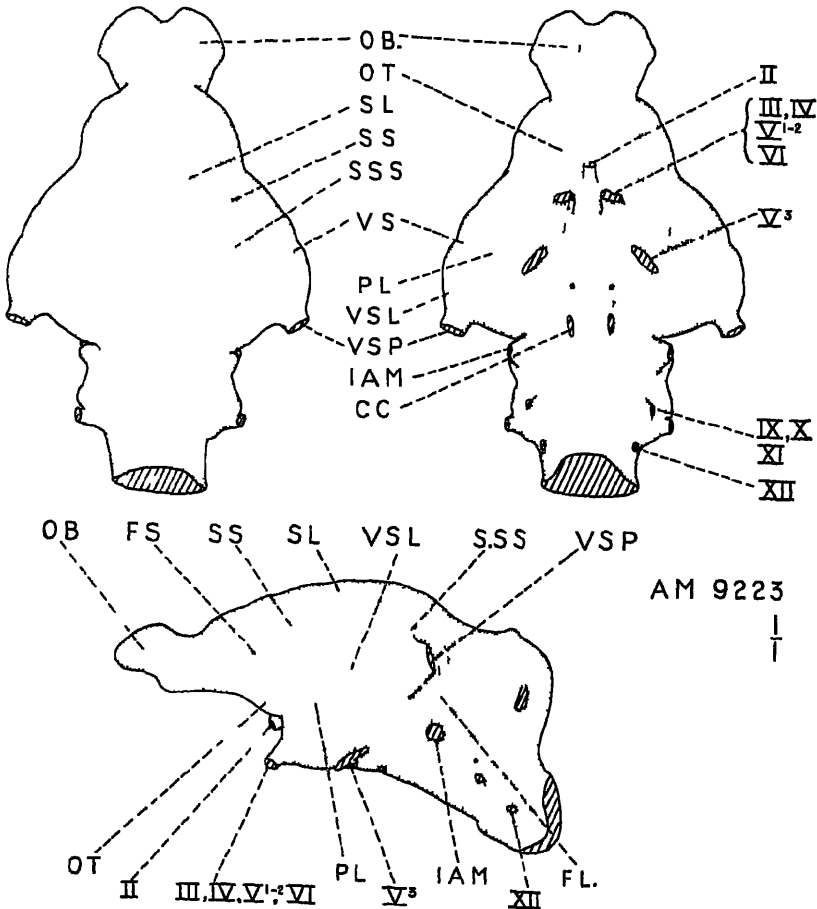


Fig 1. *Hegetotherium mirabile*. Brains from Amer. Mus No. 9223. Dorsal, ventral, and left lateral views. For abbreviations see p. 17. Natural size.

The rhinencephalon, as a whole, is well developed, but in a different way from either *Phenacodus* or *Notostylops*. The olfactory bulbs have become smaller, not only relatively but even absolutely. Shape and

proportions are more like *Phenacodus* than *Notostylops*, each bulb about as broad as long and somewhat compressed dorsoventrally. The fila originated on almost the whole ventral surface, which is inclined forward. The bulbs were separate only at the tips. The peduncles are short and even stouter, relatively, than in *Phenacodus*.

The olfactory tubercles are not significantly different from those of *Notostylops*. The pyriform lobes are very large but are purely ventral, not visible at all in dorsal view. Their maximum width is almost exactly that of the neopallium, but, in marked distinction from *Notostylops*, they do not extend as far posteriorly as does the neopallium. Expressed differently, presupposing an ancestral condition near *Notostylops*, the neopallium has expanded somewhat laterally and decidedly posteriorly. The pyriform lobes have, however, expanded downward and forward, and also are crowded toward the midline.

The outline of the neopallium is not greatly unlike that of *Notostylops*. The anterior end has expanded only slightly, and posterior and posterolateral expansion has been proportionate, retaining the triangular contour. But whereas the most posterior point on the cerebrum of *Notostylops* was lateral, it is here nearly median. The rhinal fissure is largely obscured by a large venous sinus and foramen, but there is no doubt that it lay approximately along this sinus. The part anterior to the fossa sylvii is clearly visible. The fossa sylvii is much as in *Notostylops*, but relatively slightly smaller and more anterior. From it a distinct fissura sylvii runs upward and backward. There is a sharp sulcus lateralis, sagittal but with its ends curving slightly outward and terminating in distinct pits. Another sulcus, less definite, which may be called suprasylvian for descriptive purposes (perhaps not strictly homologous with that sulcus in any other mammals), begins near the posterolateral corner and runs anterointernally past the upper end of the fissura sylvii, where it seems to be slightly interrupted, and on the left side, but not the right, runs into the sulcus lateralis. Anterior to the sulcus lateralis, in the coronal region, there is a depression, like a dimple, but it can hardly be called a sulcus. This convolution pattern is certainly more definite and perhaps more complex than those of *Phenacodus* or *Notostylops*, but there is no basic difference beyond the natural further differentiation and deepening of the sulci, and even this may be more apparent than real, so far as the underlying brain itself was concerned.

There is a swelling in the region of the hypophysis, but the expansion of the pyriform lobes toward the midline has crowded this so that it is not distinctly bounded.

The occipital exposure of the cerebellum is large, particularly deep. The dorsal exposure, in a limited sense, separated from the occipital exposure by a raised transverse ridge, is very small relatively, and considerably wider than long. This space is almost featureless (except for the sinus descending from the longitudinal scissure of the cerebrum). Possibly it represents a broad anterior lobe, while the following transverse ridge is perhaps all or part of a lobulus simplex. On the occipital face there is a large, simple, convex, vertically elongate posteromedian lobule with faint traces of transverse sulci. On each side of this is another smaller vertical convexity, presumably a paramedian lobule. Superolateral to this is a squarely truncated, dorsoventrally elongate projection, which, if not due to crushing, at least was in all probability not closely occupied by a part of the brain. Anteroinferior to this, on the lateral surface of the cerebellum, is a prominent formatio vermicularis with a short, nearly vertical ascending crus and a more oblique descending crus ending in a large, roughly circular projection, lodged in the petrosal and doubtless representing, at least in part, the flocculus. This cerebellum as a whole is clearly much more progressive, or more highly differentiated, than those of *Phenacodus* or *Notostylops*.

The nerves are arranged much as in *Notostylops* but with modifications correlated with the different development of the cortical areas. The optic chiasma, lying above the closely crowded anterior lacerate canals, is hardly visible. The optic nerves are so closely approximated that they appear as one on the cast, the thin plate of bone between them being broken on the skull. The most ventral parts of the pyriform lobes are more pointed and shorter, making the passages for III, IV, V₁₋₃, and VI shorter, and are crowded toward the midline, bringing these passages within about 2 mm. of each other. V₃ occupies the same relative position as in *Notostylops*, but, due to the shortening of the pyriform lobe, is nearer the foramen lacerum anterius.¹ The internal auditory meatus, VII and VIII, has the usual relationships, but here, due to the cerebral expansion, is at the vertical level of the posterior end of the cerebrum, instead of far posterior to this as in *Phenacodus* or, still more, *Notostylops*. The posterior lacerate foramen, IX, X, XI, is small but otherwise quite usual. The hypoglossal canal, XII, seems to be single.

The large posterolateral venous opening into the cerebral cavity, already noted for *Notostylops*, is here more lateral and even larger. From it a very prominent venous sinus runs anteriorly near or along the fissura rhinalis to the fossa sylvii. Posterior to the fissura rhinalis it gives off a

¹On the cast the size of V₃ is much exaggerated by breakage around the foramen.

small dorsal tributary. Another larger tributary runs upward and forward from near the large foramen, and a smaller vein, independent of the large lateral sinus, passes directly upward and forward from the foramen, and another, longer, straight downward and forward.

There is a small pair of foramina between V_3 of the two sides, and one still smaller in the periotic immediately dorsoanterior to the posterior lacerate foramen. The entocarotid enters the cranial cavity about 3 mm. from the midline between the levels of V_3 and VII-VIII, a position almost exactly as in *Phenacodus* and presumably primitive but secondarily lost in *Notostylops* (as in most notoungulates, being crowded out of position by the expanded bulla).

In a few points, such as entocarotid or the shape of the olfactory bulbs, *Hegetotherium* resembles *Phenacodus* more than it does *Notostylops*. These perhaps are among the characters distinguishing the Notostylopidae from the generalized notoungulate ancestry. In general, however, *Hegetotherium* shares with *Notostylops* the principal points by which the latter differs from *Phenacodus*.

The brain of *Hegetotherium* differs from that of *Notostylops* in many respects, but with few probable exceptions these are due to evolutionary advance, and could be, with considerable probability were, derived from the *Notostylops*-like type. Among the outstanding distinctions of *Hegetotherium* are:

1. Brain length and, to greater degree, brain volume relatively greater.
2. Midbrain fully and hindbrain partly excluded from dorsal exposure.
3. Olfactory lobes relatively much smaller than in *Notostylops* and of somewhat different form.
4. Pyriform lobes not visible dorsally, expanded antero-medio-ventrally.
5. Neopallium relatively and absolutely larger, expanded laterally and, especially, posteriorly.
6. Sulci perhaps more complex.
7. Cerebellum considerably more highly differentiated, relatively shorter and deeper.
8. Optic nerves retracted above the approximated anterior lacerate canals.
9. Entocarotid more as in *Phenacodus*.

The principal dimensions are:

Length of skull.....	115	mm.
Dorsal length of brain, oblique, including medulla oblongata.	61	mm.
Dorsal length between verticals, excluding medulla.	59	mm.
Length olfactory bulbs.....	9.5	mm.
Width across olfactory bulbs... ..	15	mm.
Length cerebrum.	35	mm.
Width across cerebrum.....	40	mm.
Length cerebellum (exposed dorsal part).....	14	mm.
Width across cerebellum (flocculi)....	21	mm.

Protypotherium

This braincast is taken from a skull of *Protypotherium* sp., Amer. Mus. No. 9246, found by Barnum Brown in 1899 in the Santa Cruz Formation at Felton's Estancia, Río Gallegos, Santa Cruz. The cast lacks much of the olfactory bulbs, all of the ventral surface, and the occipital surface. Although thus very imperfect, it serves to show that the better cast of *Hegetotherium* is not exceptional but is typical of at least the typotheres at this stage of development.

The cast is smaller than that of *Hegetotherium*, but belongs to a smaller animal and had about the same size relations to the skull and to

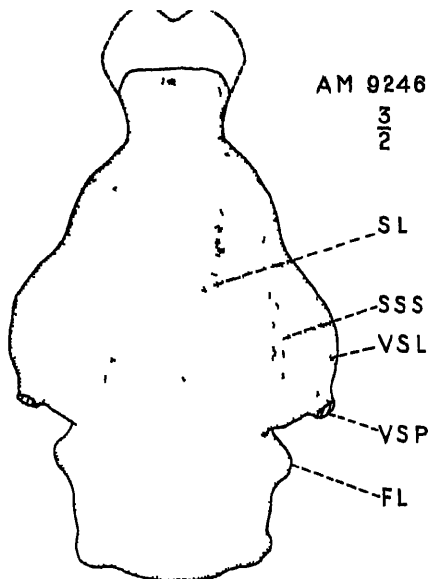


Fig. 2.—*Protypotherium* sp. Braincast from Amer. Mus No 9246. Dorsal view. For abbreviations, see p. 17. One and one-half times natural size.

the animal. Its general characters are those of *Hegetotherium* and it suffices to point out the principal differences:

1. The cerebellum is slightly less covered by the cerebrum and hence has a relatively very slightly longer dorsal exposure.
2. The neopallial sulci are less deeply marked, but have nearly the same pattern, except that, as in *Notostylops*, the anterior part of the suprasylvian sulcus is weak or absent and there is no sulcus or depression in the coronal area.
3. The anterior lobe of the cerebellum is more clearly divided into central and

lateral parts (a difference not structural but due to its being less obscured by venous sinuses and cerebrum).

4. The tentorium was more nearly vertical, and the internal auditory meatus more nearly directly beneath the flocculus

Judging from the foramina and form of complete skulls, the ventral characters were not more distinctly different from *Hegetotherium*, except that the entocarotid did not enter by a separate canal. The brain of *Protypotherium* is clearly very similar to that of *Hegetotherium*, but is slightly more primitive. It is very much closer to *Hegetotherium* in grade of development than to *Notostylops*. The dental and osteological anatomy agrees with this general impression, showing that *Protypotherium* is rather closely allied to *Hegetotherium*, although placed in a separate family, and is in a nearly comparable stage of evolution but retaining a few more primitive characters.

NOTES ON THE NOTOUNGULATE BRAINCASTS DESCRIBED BY GERVAIS

Gervais (1872, pp. 426-436; Pl. xx; Pl. xxi, Fig. 11) described braincasts of *Toxodon* and of *Typotherium cristatum* from the Pampean. Each cast was figured in dorsal view only. Edinger (1929, pp. 194-195, Figs. 184-185) reproduced stipple copies of Gervais's lithographs and briefly referred to the morphology.

In *Toxodon*, the olfactory lobes are relatively small but fully exposed, widely separated from each other, and compressed laterally. In the general outline of the cerebrum, the striking features are the relatively posterior position of the sylvian emargination and relatively great width of the anterior part of the neopallium. In other words, the pre-sylvian part of the cerebrum has increased in size (from a condition more like the early notoungulates here described) relatively faster than has the posterior part. There were apparently more sulci than in the other forms described here, but they cannot be traced or identified on Gervais's figure. The cerebellum was depressed and almost fully exposed. A prominent but relatively narrow vermis is seen in the figure. It seems that the brain of *Toxodon* has been modified by change of habits, by increased size of the animal, and to some extent by evolutionary advance, although even in this very late notoungulate it cannot be called a very progressive brain. These changes have masked any special resemblance to early notoungulates in the parts shown. It is probable that the lateral and ventral sides would show clearer traces of an ancestral structure more like that of, for instance, *Hegetotherium*. No earlier toxodont braincast is at present available to me.

The braincast of *Typotherium*, in dorsal view, is remarkably like that of *Hegetotherium* or *Protypotherium*. The outline and proportions are nearly identical, and the only significant difference to be observed in Gervais's figure is the lesser development of the dorsal sulci. The difference is apparently not due to any real difference of pattern, and probably is merely due to the less exact impression of the sulci on the overlying bones.

The braincasts of *Toxodon* and of *Typotherium* are so unlike that Gervais considered these animals as unrelated to each other. But the early forms are so similar in dental and skeletal structure that toxodonts and typotheres are now believed to be closely related. Probably when early toxodont braincasts are available, these, too, will be much like those of typotheres. The toxodont brain underwent more modification than did that of the typotheres.

Proterotherium

An artificial braincast of *Proterotherium curum* has been prepared from Amer. Mus. No. 9245, found by Barnum Brown in 1899 in the Santa Cruz Formation at Felton's Estancia, Río Gallegos, Santa Cruz. This splendid skull was fully described and figured by Scott, but the braincast has not hitherto been described in any member of the Order Litopterna. By utilizing cracks already present, it was possible to open the cranium transversely across the cerebral hemispheres, and so to add to the value of the specimen by the preparation of this excellent and unique braincast without any permanent damage to the skull.

The total length of the skull is 180 mm., and of the brain, exclusive of medulla, 91 mm., giving an index of 51. In an animal of larger size and longer rostrum, both tending to give a low figure, this indicates a brain effectively distinctly larger than that of *Notostylops*, with an index of 48, and probably even effectively larger than that of *Hegetotherium*, which also has an index of 51 but is somewhat smaller and has a shorter rostrum. This is substantiated by the anatomical features, and both in effective size and in structure the brain is more highly evolved than the others here described.

Axial flexure is somewhat less than in *Hegetotherium*. The olfactory bulbs are fully visible dorsally and the cerebellum is only very slightly overlapped, but the midbrain was wholly concealed. The ratio of olfactory bulbs, cerebrum, and cerebellum is about 1:5:3. The exposed length of the cerebellum is greater, relative to the cerebrum, than in *Hegetotherium* and not markedly different from the early notoungulates or

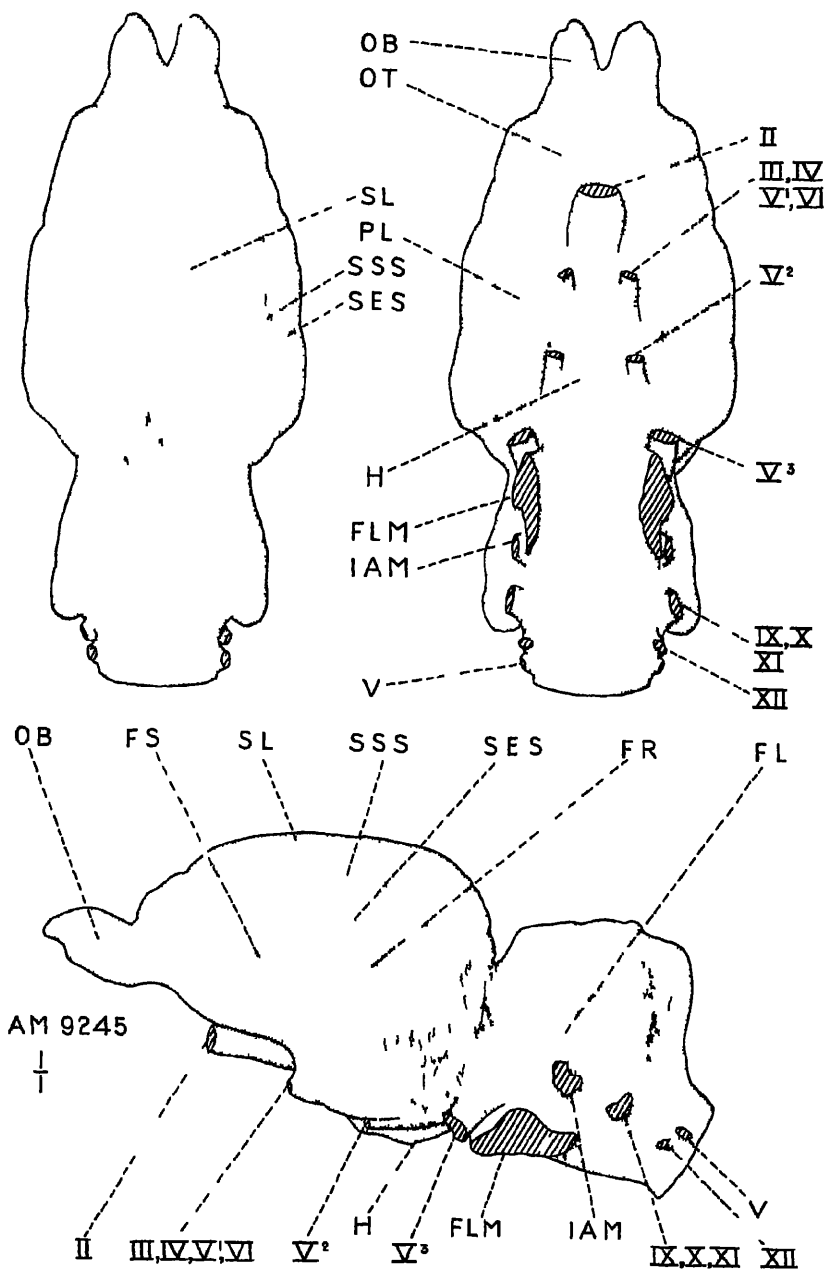


Fig 3—*Proterotherium cavum*. Braincase from Amer Mus. No 9245. Dorsal, ventral, and left lateral views. For abbreviations, see p 17. Natural size.

Phenacodus, but the olfactory lobes are much smaller relatively than in any other cast here described. Olfactory bulbs and cerebellum are slightly and about equally depressed below the dorsal level of the neopallium.

The olfactory bulbs are unlike those of the other genera here described in being compressed laterally, the depth of each nearly equal to the length but the width considerably less. They are separated by a deep notch, continued into a median sulcus between the peduncles ventrally but not continuous with the longitudinal scissure dorsally. The olfactory tubercles seem to have been developed about as in *Notostylops*, somewhat more swollen but not relatively larger than in *Phenacodus*. The pyriform lobes are about equal to the neopallium in width, not or scarcely visible in dorsal view, but they are very deep, deeper than the neopallium. This expansion is almost purely vertical, less anterior than in *Hegetotherium*, less posterior than in *Notostylops*, and less lateral than in *Phenacodus*. On the ventral surface of each pyriform lobe there is a prominent circular pit, the significance of which is not clear.¹

The shape of the neopallium is unlike that of any of the other casts here described, most nearly resembling *Phenacodus* except for its greater length and slightly less disparity in anterior and posterior widths. It is about one-fourth longer than wide, pyriform and with the greatest width posterior to the middle, but less triangular than the other casts and with the width more nearly the same throughout. The surface features are more clearly marked than on any other of this series of casts, even better than in *Hegetotherium*, and must reproduce the actual brain convolutions very closely. The brain is rather strongly gyrencephalic, and the presence of four sulci and the rhinal fissure on each side, all nearly straight and parallel to each other and to the longitudinal scissure, give it a very peculiar, almost mechanical or artificial appearance.

The rhinal fissure is very clearly and deeply impressed, becoming a little vague only anterior to the fossa sylvii, and is almost horizontal and straight in lateral view. The fossa sylvii is small and not very distinct. It does not form a lateral emargination to the same degree as in *Notostylops*, for instance. From it a short sulcus runs obliquely upward and backward, terminating at the most ventral of the longitudinal sulci. The latter, descriptively and perhaps functionally ectosylvian, is the least uniform of the series and is formed by a line of depressions rather loosely united into a longitudinal groove beginning near the pos-

¹For possible future students of the cast, it should be noted that the still larger pit on the lateral surface of the left pyriform lobe is an artifact. It has been omitted in the drawings.

terior border and running forward to within about 7 or 8 mm. of the frontal pole. Above this is a nearly straight and even longitudinal sulcus, nominally suprasylvian, similar in character to and only very slightly shorter than the sulcus lateralis. These two, suprasylvian and lateral, are joined between their anterior ends by an obliquely transverse sulcus, from which another very short but (on the right side, at least) deep sulcus directed anteriorly also arises. This complex, uniting the lateral and suprasylvian sulci, produces somewhat the effect of coronal or coronal and ansate sulci in some other groups of mammals, but the relations in detail are unlike those on any other brain known to me, and it is highly probable that these sulci (and others, except probably the sulcus lateralis and possibly the suprasylvian) do not have any real homologues in any other mammalian order. Between the lateral and suprasylvian sulci there is another, nominally ectolateral, parallel to them and of similar character except that it is shorter, not reaching the transverse "corono-ansate" sulci and hence leaving the gyri above and below it continuous around its anterior end. These three longitudinal sulci all end freely and independently near the posterior border.

The fossa hypophyseos has been crushed so that its mold appears as a high sharp ridge on the cast. Apparently it was rather prominent.

The separation of the cerebellum is very deep and clear-cut, even more than in *Phenacodus*, the skull having a very strongly developed tentorium. In its gross modeling, the cerebellum shows considerable resemblance to *Phenacodus*, less to the other casts of this series. Its details are clearer and probably its structure was really more complex, although even in this case it is impossible to work out detailed relationships and divisions. Anteriorly there is a median lobe with no clear evidence of convolution, divided (probably by the fissura prima) into a small anterior lobe, almost hidden in the deep cleft formed by the tentorium, and a larger posterior part, probably the lobulus simplex. Posterior to this the dorsal portion of the cast becomes trifid. The lateral portions, apparently highly foliated, pass backward, slightly outward, and, particularly in their more posterior parts, downward. They probably are or include ansiform and paramedian lobules. The postero-median lobule, with rather vague traces of convolution, forms an almost pyramidal point at the occipital pole and then sinks vertically to the medulla, very much as in *Phenacodus*. Lateral to the lobulus simplex and perhaps pertaining to it but separated by longitudinal grooves, are smooth hemispheres. Lateral to all these parts and much obscured by peri-petrosal fissures and postmortem crushing, is a looped projection,

in part or wholly a *formatio vermicularis*, apparently with a short nearly vertical posterior crus and a more expanded and more oblique anterior crus. Much of the latter, undoubtedly more than a flocculus strictly speaking, is lodged in a shallow excavation in the petrosal, but this part is less sharply defined and considerably less salient than in *Notostylops*, for instance.

The nerve exits can all be unmistakably identified. The large optic nerves are confluent on the cast, due to postmortem destruction of the intervening septum, and are well in advance of and slightly above the following passages. The confluent casts of the other orbital nerves, III, IV, V₁, and VI, are relatively rather small (doubtless because the large maxillary nerve is not included with them), and occupy the usual position between the anterior ends of the pyriform lobes. V₂ can be closely traced, arising medial to V₃, running downward and forward, and becoming free of the cast (entering its separate canal) 7 or 8 mm posterior to the single exit of III, IV, V₁, and VI. This separate exit of V₂ is a marked distinction from the other casts of this series.¹ The brain-cast representation of V₃ is also very peculiar and unlike any other cast here described. On the other casts, this nerve is represented by a stalk on the ventroposterior part of the pyriform lobe (far removed from the true point of origin of this nerve on the original brain). In other words, the internal opening of the foramen ovale in these forms is anterior to the tentorium osseum. In the present case, on the contrary, the very large V₃ arises on the cast on its cerebellar portion, anterior to and slightly below the internal auditory meatus, at what must have been the actual point of origin on the brain itself. It runs downward and forward, in the same direction as V₂ but leaving the cast long before the latter. The foramen ovale is posterior to the tentorium.

Loss of the tympanic has left a large gap on the skull at and posterior to the position of the median lacerate foramen and represented on the cast by a heavy triangular stalk. The internal carotid doubtless entered the skull somewhere along this gap. The internal auditory meatus is near the middle of a large petrosal fossa on the cast, well posterior to the cerebrum. The filling of the posterior lacerate foramen (IX, X, XI) is posterior and ventral to the internal auditory meatus, and at about an equal distance from the former, in the same direction, is the exit of XII. On the skull dorsoposterior to the latter and enclosed with it (the con-

¹Scott stated that foramen ovale and foramen rotundum are confluent in the *Latopterna*. I have elsewhere suggested that this is highly improbable, *a priori*, and that the foramen rotundum was probably confluent with the anterior lacerate foramen. The endocranial anatomy proves that the latter is the true condition. What can only have been V₃ leaves the endocranial cavity separately, but its external exit is confluent with the anterior lacerate foramen, and very distant, at least 22 mm., from the foramen ovale.

dylar foramen) in a common pit, is a vascular foramen leading into the cancellae of the occipital bones.

This brain is, on the whole, a progressive one, but progressive in a direction not exactly paralleled in any other group. It thus accords with the other indications of affinity of the Santa Cruz litopterns, the only unexpected feature being the suggestion of more progressive development than in the associated typotheres. The effective size of the brain is relatively great, the olfactory bulbs are small, the neopallium (particularly its anterior part) is expanded and rather richly convoluted, and the cerebellum is large and complex. Correlated with osteological evidence of a fleet and at least superficially progressive plains-dwelling animal, the brain suggests in general intricate muscular coordination and dominance of visual, tactile, and kinesthetic senses over the more primitive olfactory and related sensual and cerebral organs.

So far as indications of affinity go, they are chiefly negative. The brain adds its evidence against the now universally abandoned theory of perissodactyl relationships for the Litopterna. It has no special resemblance to any perissodactyl brains known to me, and perhaps least of all to the early horses (*Meshippus* has been compared). It also opposes any close union with the Notoungulata, differing in various fundamental features from any of the notoungulate braincasts yet available. On the positive side, the braincast of *Proterotherium* might easily be fitted into a preconceived theory, or one based on other evidence, but in fact is quite inconclusive. Thus it could very well have been derived from a brain like that of *Phenacodus*, but, in accord with its much younger age, it is decidedly more progressive and is too deeply modified from the *Phenacodus* stage, if it did pass through it, for any certain and objective recognition of affinity. Good evidence on this point could come only from older braincasts, of *Notostylops* or *Astraponotus* age, but there is no immediate prospect of obtaining these.

The principal dimensions follow:

Length of skull	180 mm.
Length of brain exclusive of medulla.	91 mm.
Length of olfactory bulbs (dorsal).	10 mm.
Width across olfactory bulbs	15 mm.
Dorsal length of cerebral hemispheres.	51 mm.
Width across cerebral hemispheres	40 mm.
Length of cerebellum	28 mm.
Width across cerebellum.	29 mm.

CONCLUSIONS AND SUMMARY

Something is now known of characteristic braincasts of the more common and important South American ungulates.¹ This information is inadequate for any final conclusions, but does lead to some preliminary suggestions.

The oldest notoungulate braincasts, and the only ones that seem to be sufficiently unmodified to give some idea of ancestral structure in the group, are those of *Notostylops*, *Oldfieldthomasia*, and *Rhyphodon*. *Notostylops* and *Rhyphodon*, although apparently equally primitive, differ more than would have been anticipated, particularly as they are commonly referred to the same suborder. It is a reasonable theory that the characters shared by these casts probably nearly represent the ancestral notoungulate characters in general. The more important of these characters are:

1. Brain arrangement nearly serial.
2. Olfactory bulbs and cerebellum fully exposed dorsally, and midbrain partly exposed.
3. Olfactory bulbs very large, about one-half to one-third as long as the cerebral hemispheres, and cerebellum (in dorsal exposure) varying from as long as the olfactory bulbs to about twice their length
4. Olfactory tubercles rounded swellings, low but distinct.
5. Pyriform lobes very large but shallow, visible in dorsal view laterally or posterolaterally.
6. Cerebral hemispheres as a whole triangular, much narrower anteriorly than posteriorly, shallow and somewhat flattened dorsally.
7. Rhinal fissure nearly or quite continuous and approximately horizontal
8. Distinct sylvian fossa, placed well forward, and causing a lateral emargination in the cerebral outline.
9. Slightly gyrencephalic. Sulci poorly impressed on bone and probably shallow. A short sylvian fissure, a posterior suprasylvian sulcus, and a lateral sulcus probably primitive for the group.²
10. Fossa hypophyseos variable but not very deep or sharply defined in any case.
11. Cerebellum with relatively very large vermis, divided serially into two or more lobules, and rising to a node, of varying prominence, at the top of the occiput.
12. Lateral lobules or cerebellar hemispheres small and probably poorly subdivided or differentiated
13. Formatio vermicularis, or its apparent gross anatomical equivalent, roughly in the form of an inverted V, the posterior crus longer than the anterior, the angle between them variable.
14. Despite the condition in *Rhyphodon*, it is highly probable that the lodging

¹The rarer *Astrapotheria* and *Pyrotheria* are still quite unknown in this respect, but each of the other major groups is now represented by at least one typical example.

²One or the other of the two latter may have been absent in *Rhyphodon*, but this is quite uncertain, and it seems highly probable both were present in the ancestral notoungulates or appeared very early in the various groups.

of a nominal "flocculus" in a petrosal fossa anterior to the meatus is primitive for the group

15. Cranial nerves, as they appear in the cast, grouped as follows. (a) I (multiple exits); (b) II¹; (c) III, IV, V₁₋₂, VI; (d) V₃; (e) VII, VIII; (f) IX, X, XI, and (g) XII.

16. II between, slightly above, and anterior to the common canal of III, IV, etc. The latter at the anteromedian point of the pyriform lobe.

17. V₃ appearing on cast as a nearly vertical stalk on the posteroventral part of the pyriform lobe.

No important common features of the endocranial circulation are observed. Both *Notostylops* and *Rhyphodon* have peculiar and very prominent vascular exits from the cerebral fossa, but they are not homologous in the two cases and the primitive condition cannot be inferred.

Most of these characters are doubtless primitive in a general sense, yet it is surprising how distinctive they are in aggregate. Checking over the known braincasts,² with a single exception there is not one that could be confused with the inferred ancestral notoungulate type. It does seem, therefore, that these data give an adequate and distinctive definition on endocranial characters of a natural group of mammals. For instance, even the earliest known artiodactyl (Lower Eocene) or perisodactyl (Middle Eocene) braincasts are obviously and fundamentally different from the notoungulate type. This is likewise true, although to less degree in various points, even of such archaic ungulates as the amblypods (*sensu lato*) so far as these are known.

The exception to this exclusion from the notoungulate braincast type is of extraordinary interest and possibly of essential phylogenetic significance. *Phenacodus* has every one of these characters and cannot be separated from the Notoungulata on the basis of the endocranium. This appears also to be true of other genera, e.g. *Pleuraspidotherium* (see Edinger, 1929), which are also placed in the Condylarthra, but they are inadequately known. The theory is quite justified and seems to be supported by excellent, if not conclusive, evidence that the notoungulate brain evolved from a type otherwise known only in the condylarths and quite distinct from any others known, even those of comparable or greater age and comparably or more primitive in general structure.

The evidence of the braincast is not more certain than any other sort of evidence, belongs to no different category, and involves quite as

¹II appears to have no separate exit in *Rhyphodon*, but its older allies show that this is anomalous or secondary

²Particularly Edinger, 1929, also Tilney, and the literature cited by those authors. There are also a few braincasts in the American Museum which are not included in these general reviews or have not been described at all

much personal judgment. It is not the hoped-for but probably non-existent datum that might reduce the large subjective element in phylogeny and improve the character of this very inexact science. Its value is in multiplying the data on which conclusions can be based and thus giving better grounds for personal opinion. Also, like other sorts of characters, it sometimes preserves clues which have been lost or disguised in other parts of the anatomy. The present case, with its clear suggestion of derivation of the Notoungulata from the Condylarthra, may be an example of this, but of course must be thoroughly correlated with all the other evidence before a final conclusion is drawn.

Turning to the Typotheria, the development of their brains from the primitive notoungulate type as outlined above seems fairly clear. Their dentitions became rapidly and profoundly modified between *Notostylops* and Santa Cruz time, but otherwise they were a conservative group. Directly ancestral stages are not known, but the series *Notostylops-Hegetotherium-Typotherium*, Eocene-Miocene-Pleistocene, represents a tentative structural sequence probably valid in a broad way. This sequence suggests that during the period of their most rapid dental evolution, Eocene to Miocene (or into the Oligocene when the advanced dental type was already fairly established), the brain also advanced, chiefly by reduction of the olfactory bulbs and moderate expansion and differentiation of the neopallium, but not enough to conceal its ancestral characters. From Miocene to Pleistocene the brain seems to have been relatively static. Even in the latest typotheres, the brain was of very low type (note Gervais's confusion of it with the rodent brain). As nearly as one can make such a comparison, the latest and most specialized typotheres stood about on the same level of brain development as the earliest and least specialized artiodactyls and perissodactyls.

The braincasts suggest considerably closer relationship between *Notostylops* and the typotheres than between either of these and *Rhyphodon*.

While it has the distinctive notoungulate stamp, the braincast of *Rhyphodon* is peculiar. It suggests, but on evidence inadequate for any positive assertion, that the homalodontotherine brain diverged decidedly from those of other notoungulates and was conservative or even degenerate. *Homalodontotherium* itself, relatively gigantic in size, probably had brain modifications, not necessarily progressive, such as invariably accompany great skull size regardless of the factors of true neurological or mental advance.

For the toxodonts, *sensu stricto*, we have as yet only the inadequate

data given by Gervais for the last of this line, *Torodon* itself. Here the effects of gigantism, a rather broad massive braincast and increased convolution, are visible and tend to obscure more fundamental characters. Also the great time gap from Eocene to Pleistocene corresponds with evolutionary change which makes the braincast of *Torodon*, so far as it is known, practically unrecognizable as being notoungulate. This does not oppose the general conception of a notoungulate brain type and its differentiation, but merely demands intermediate material for elucidation.

The braincast of *Proterotherium* is somewhat more progressive than that of contemporaneous typotheres, is developing along different lines, and shows no evidence of special relationships to the notoungulates. Common origin from a condylarth type is a possibility, but is not an inevitable conclusion on the available data. *Proterotherium* seems to be quite distant from the typotheres and probably from notoungulates in general, a member of a very distinctive order, and the braincast of this relatively late form suggests no definite connection with any other group.

ABBREVIATIONS ON TEXT FIGURES

II—Optic nerve (filling of optic canal).

III, IV, V₁₋₂ [or V₁], VI—The common canal of these nerves, the anterior lacerate foramen.

V₂—Maxillary nerve.

V₃—Mandibular nerve.

IX, X, XI—Common canal of these nerves (posterior lacerate foramen)

XII—Hypoglossal canal (condylar foramen).

C C.—Carotid canal.

F L.—"Flocculus," or cerebellar lobule lodged in petrosal.

F.L.M.—Foramen lacerum medium.

F R.—Rhinal fissure

F S.—Fossa sylvii.

H.—Filling of fossa hypophyseos.

I.A.M.—Internal auditory meatus (nerves VII–VIII).

O.B.—Olfactory bulb.

O.T.—Olfactory tubercle.

P L.—Pyriform lobe.

S.E.S.—"Ectosylvian" sulcus.

S L.—Lateral sulcus.

S.S.—Sylvian fissure

S.S.S.—Suprasylvian sulcus.

V.S.L.—Lateral cerebral venous sinus.

V.S.P.—Posterior venous passage from cerebral fossa.

NOTE

Loomis (The Deseado Formation of Patagonia, 1914, p. 79) has figured a braincast of *Eutrachytherus*. Although they probably will necessitate no essential modification of the views here expressed, the characters of the brain of this aberrant genus are so difficult to ascertain and interpret from the illustrations and brief description available that discussion is deferred and not attempted in this preliminary paper.

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THE BENTONITES AND CLOSELY RELATED ROCKS OF PATAGONIA¹

By G. C. McCARTNEY

The present paper records a number of interesting features noted in the study of a suite of rocks collected in Central Patagonia by Dr. G. G. Simpson while leader of the Scarritt Patagonian Expedition. The study is concerned primarily with the petrographic and physical character of the rocks. The suite of rocks is of particular interest, since in addition to features described in this paper it represents geologic formations known to contain fossil mammals of early Tertiary age.²

An outstanding result of this work is the recognition that almost the entire Lower Tertiary of Central Patagonia is bentonitic in character and that much of it is a rather pure bentonite.

Information in regard to stratigraphic and structural relations of the rocks in the field has been obtained from the field notes of Doctor Simpson.

The mammal-bearing rocks of Central Patagonia have been recognized as tuffs and as such are described briefly by María Casanova.³

It is a fact that tuffs, for the most part volcanic ash rather than tuff, do occur in the Lower Tertiary of Patagonia, but they are not the most abundant rock type; by far the greater proportion of the so-called tuffs are really bentonites or rocks intermediate between tuff or volcanic ash and bentonite. It is the presence of considerable amounts of the mineral montmorillonite together with a texture derived from volcanic ash that has led to the identification of such rocks as bentonites.

Considerable research has been done on the physical, chemical and petrographic properties of bentonite by such investigators as Ross, Shannon, Spence, Kerr, and others⁴; the properties are described in the papers cited

¹Publications of the Scarritt Patagonian Expedition, No 17.

²Simpson, G. G.—Personal communication.

³Casanova, María. 1931. 'Apuntes petrográficos sobre los terrenos atravesados por los pozos de Comodoro Rivadavia y sus alrededores.' Contribuciones a la primera reunión nacional de geografía, Buenos Aires, Mayo-Junio de 1931. V.

⁴Ross, C. S., and Shannon, G. V. 1926. 'The Minerals of Bentonite and Selected Clays and Their Physical Properties.' Journ. Amer. Ceramic Soc., LX, No 2, pp 77-96.

Ross, C. S. 1928. 'Altered Paleozoic Volcanic Materials and their Recognition.' Bull. Amer. Assoc. Pet. Geol., XII, No. 2, pp 143-164, Feb.

Spence, H. S. 1924. 'Bentonite,' Mines Branch, Dept. of Mines. Ottawa, Canada, No. 626.

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Ross and Shannon define bentonite as follows: "Bentonite is a rock composed essentially of a crystalline clay-like mineral formed by devitrification and the accompanying chemical alteration of a glassy igneous material, usually a tuff or volcanic ash; and it often contains variable proportions of accessory crystal grains that were originally phenocrysts in the volcanic glass. These are feldspar (commonly orthoclase and oligoclase), biotite, quartz, pyroxene, zircon, and various other minerals typical of volcanic rocks. The characteristic clay-like mineral

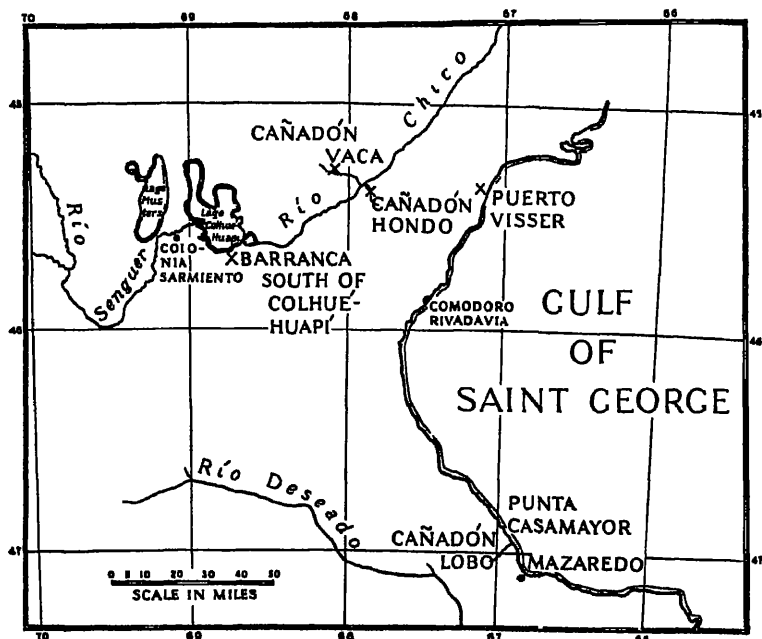


Fig. 1.—Sketch map of central Patagonia, showing the localities mentioned in the text. (After Simpson, previously unpublished.)

has a micaceous habit and facile cleavage, high birefringence and a texture inherited from volcanic tuff or ash, and it is usually the mineral montmorillonite,¹ but less often beidellite."²

Before giving a detailed description of the bentonites, it seems in order to describe the volcanic ashes, since they are the parent rocks of the bentonites.

¹Montmorillonite was described in 1847 by Damour and Salvétat. 1847 Ann Chimie et de Physique, 3d Series, XXI, p. 376

²Larsen, E. S., and Wherry, E. J. 1925. 'Beidellite, a New Mineral Name' Journ. Wash. Acad. Sci., XV, pp. 465-468

The typical volcanic ash is a rock, light in color, i.e., gray or light brown, medium to fine-grained, often very porous and distinctly gritty to the touch. In thin section the ash is seen to consist almost entirely of irregular-shaped fragments of volcanic glass. The glass fragments are usually angular and show a distinct conchoidal fracture; occasionally a spherical-shaped mass is seen. Such masses represent volcanic glass bubbles. In addition to the volcanic glass there are always a number of fragments of such minerals as feldspar, both orthoclase and plagioclase of albite to andesine composition, and quartz. Usually a few fragments of pyroxene, amphibole, magnetite, epidote, zircon, biotite and chlorite are present.

Some of the ash beds contain geodes which are composed of quartz, banded-chalcedony and opal, while others have tiny veinlets of quartz and chalcedony irregularly distributed through them. The quartz, chalcedony and opal in the form of geodes and veinlets are evidently a secondary product.

The bentonites of Patagonia are typically very clay-like in appearance, and are similar to the ash rocks in color except that yellow and buff color are more predominant. Macroscopic examination reveals at least two and sometimes three rather distinct types. The first is very compact and is smooth or slippery to the touch; the second is more loosely aggregated, i.e., powdery in nature, and is slightly rough to the touch, and the third, though not always distinct from the second, is massive and hard and usually very rough to the touch. An important physical property of some bentonites is to increase in volume very perceptibly when placed in water. Spence¹ records an increase of 13.8 times its original volume when a certain bentonite was allowed to take up all the water it would hold and still retain its form. Many of the Patagonian bentonites illustrate this property of swelling when placed in water. A distinct relationship seems to exist between the type of bentonite and its behavior when placed in water. The compact bentonite swells to many times its original volume when placed in water, and the resultant mass resembles very closely a mass of jelly. In this bentonite the particles tend to hold together even when the bentonite is subjected to great increase in volume, i.e., the mass is more or less coherent in the swollen state. A curious feature of the reaction of this bentonite to water is the fact that in the process of increase in volume, angular fragments of the original dry bentonite fracture and spread apart along lines of intersection of two or more faces of the fragment; each face of the fragment

¹Spence, H. S. 1924. *Idem*—Pl. iv

then tends to curl or roll into a ball, and finally the entire fragment forms a globular-shaped mass. The powdery type of bentonite behaves very differently in water. It increases in volume considerably but does not maintain or develop definite form; it rapidly disintegrates into small particles and slumps down into the bottom of the container. The third type of bentonite gives no visible physical reaction when placed in water.

The different behavior of the various bentonites is due to the physical condition of the material. The explanation for the rather curious fracturing along acute edges of an angular fragment of the compact bentonite in water seems to lie in the fact that the intersections of faces of the fragment represent the points of greatest stress in the rock consequent upon the sudden great increase in area of each of the faces of the fragment.

The difference in behavior in water of the bentonites is quite distinct, but a similar distinction cannot be made in petrographic study. The petrography of the Patagonian bentonites is very similar to that of the bentonites described by Ross and Shannon.¹

Petrographic examination of a typical bentonite reveals a rock that is, in the main, composed of an aggregation of tiny montmorillonite crystals. In some bentonites the montmorillonite is developed in such quantity that it forms a closely woven network of small crystals; in others, there is a distinct tendency for the montmorillonite to be developed along the borders of fractures in the rock. In addition to the montmorillonite there are always present a few fragments of quartz and feldspar—occasionally orthoclase but more often plagioclase of albite to andesine composition. Ferromagnesian and other high specific gravity minerals are usually present; they are always in very small quantity.

The most common rock type in the Patagonian suites is one intermediate between a volcanic ash and a bentonite. These rocks are seen in thin section to be composed mainly of shards of volcanic glass and of montmorillonite. The glass fragments or shards are usually partially altered to montmorillonite; in such instances the montmorillonite forms a birefringent border zone around the isotropic glass. Often it is possible to note this type of alteration having taken place around a glass bubble; in such instances the montmorillonite crystals are developed like fibres which appear to be wrapped around the glass bubble. Ross and Shannon,¹ in their text figures 1a, 1b, 2a, 2b, show microphotographs of several types of bentonite. Their microphotographs illustrate the Pata-

¹Ross, C. S., and Shannon, G. V. 1926. *Idem.*

²Ross, C. S., and Shannon, G. V. 1926. *Idem.*, pp. 82-83.

gonian bentonites as thoroughly as if they were actual microphotographs of the Patagonian rocks.

Identification of the birefringent material so closely associated with the volcanic glass as montmorillonite was made through refractive index measurements and X-ray analysis. Ross and Shannon,¹ report that ". . . montmorillonite from normal bentonites has indices of refraction that vary but little from the mean values that are $\alpha=1.493$, β and γ 1.516 and the montmorillonite from other sources shows nearly the same values." The writer finds the montmorillonite of the Patagonian rocks checks very closely in its indices with that given by Ross and Shannon. In all crystals measured, $\alpha=1.49-1.50$ and β and γ very close to a value 1.51. Through the very kind cooperation of Professor P. F. Kerr of Columbia University, X-ray analyses of a few of the bentonite samples were made. Professor Kerr found that certain rock specimens, in which the writer believed montmorillonite did occur, gave X-ray diffraction patterns which agree with those given by members of the montmorillonite group.²

SECTION IN CAÑADÓN VACA

In order to show the genetic relation between the bentonite and the volcanic ash and to emphasize the stratigraphic importance of the bentonite in the early Tertiary of Patagonia, a stratigraphic section in Cañadón Vaca (see Fig. 1) is described in detail. The accompanying diagram (Fig. 2) illustrates the stratigraphic sequence in the *Notostylops* Beds at one point in Cañadón Vaca, and shows by number the positions in the section of the rock specimens described in detail in the following pages. Specimens numbered R41 and R42 are different in field and microscopic appearance from anything seen elsewhere, but these differences prove to be due to the apparently different mode of deposition and to the presence of macroscopic grains or pebbles of volcanic rock, rather than to any marked difference in the essential mineralogic character of the stratum. Except for this one bed, the series is fully typical of the great bulk of the pre-Patagonian³ "tuffs." A large number of mammals of the typical *Notostylops* fauna were found in this section, scattered through it except for the level of R38, which is barren of fossils. They were to some extent concentrated in the strata represented by R45 and R47 and were rarest in the less altered tuffs, e.g., R44, R49.

¹Ross, C. S., and Shannon, G. V. 1926. *Idem*, p. 98

²Personal communication.

³For stratigraphic nomenclature and age, see Fig. 4

Like most of the pre-Patagonian Tertiary exposures, this one consists of beds from one to fifty feet thick, evenly stratified with original horizontality, but generally not sharply limited at their contacts. The rock samples show a minor number of relatively unaltered white to gray volcanic ashes, with a larger amount of true bentonite, and all intergradations between these two extremes. In the field, the purer volcanic ash rocks stand out in recurrent beds because of their whiter color and the fact that they are usually somewhat indurated or concretionary, more resistant to surface weathering. They often form minor scarps, while the bentonites form steep slopes, much checked and weathered, above and below the volcanic ash.

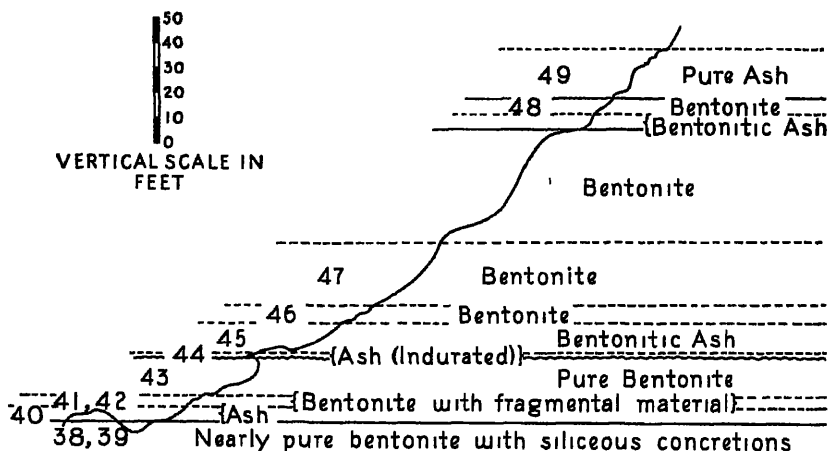


Fig. 2.—Stratigraphic section in the *Notostylops* Beds in Cañadón Vaca (After Simpson, previously unpublished)

The relation of the bentonite to the volcanic ash is very interestingly brought out in this and in other sections studied by Simpson in the field but not here given in such detail. They generally alternate, with bentonite much predominant in bulk. The base of a relatively pure volcanic ash usually shows a sharp and somewhat irregular contact, i.e., is disconformable on an erosion surface, probably in most cases representing an inappreciable interval of geologic time, but in some corresponding to a distinct faunal break. The upper contact of the volcanic ash, on the contrary, is usually vague and passes gradually into bentonite.

In some cases fossils are more common in the volcanic ash, but their greatest absolute concentration in the whole formation and their greatest relative concentration in many sections, including the present one, is in the bentonite or in the material transitional from volcanic ash to bentonite. All these facts strongly suggest intermittent heavy falls of ash alternating with periods of weathering and erosion, the latter appar-



Fig. 3.—View of the Oficina del Diablo, Cañadón Vaca, showing the lower part of the section given in Fig 2 (After Simpson, Amer Mus. Novitates, No. 566, p. 15)

The basal clays (bentonites), apparently darker in color, near or below the middle of the left half of the picture, are those represented by R38 and the hard ledge near and somewhat above the middle of the picture is the tuff represented by R44. (The large dark spot in the upper right quarter of the photograph is formed by pebbles which have fallen from the pampa, over three hundred feet above).

ently very slight in most or all cases. The purer volcanic ashes appear to represent the earlier parts of fairly rapid falls of ash, the bentonites the later parts, or slower falls. The bentonite seems thus to be due in large part to contemporary weathering. Concentration of animals in these

beds is then reasonably explained by the fact that these deposits were for a longer time at or near the surface, and that as they weathered and became bentonitic, their sticky character—when wet—would serve to entrap animals and for the rapid engulfing and burial of those that died on them for this or any other reason.

Specimen No. 38—Bentonite

FIELD OBSERVATIONS.—About 100 feet of this material underlies the fossil-bearing beds. It has no apparent bedding and is for the most part gray to cream-colored below the weathered surface, but tends to become more definitely yellowish or reddish on weathering. Concretions are abundant (see No. 39) but no fossils are found.

MICROSCOPIC EXAMINATION.—Specimen is light yellow in color, fine-grained and powdery, swells and disintegrates rapidly into small particles when placed in water.

MICROSCOPIC EXAMINATION.—Montmorillonite is developed in a complete network of tiny fibre-like crystals through the rock. There is very little volcanic glass present and that only in small fragments. There are a number of large acid plagioclase and quartz fragments scattered through the rock.

Specimen No. 39—Concretion

FIELD OBSERVATIONS.—It is a concretion from the same thick stratum as the preceding specimen.

MICROSCOPIC EXAMINATION.—Specimen is a buff-colored, fine-grained concretion rendered quite hard by the introduction of silica. Numerous veinlets and pockets of chalcedony are present through the rock. Quartz and calcite are often associated with chalcedony.

MICROSCOPIC EXAMINATION.—The matrix of the rock is almost all isotropic and has a very low refractive index; it is undoubtedly a form of altered volcanic material but is not a typical bentonitic mineral. There is developed along fractures in the rock a brown-colored mica; it is very similar to montmorillonite and probably belongs to that group. There are many fragments of acid plagioclase and a few of volcanic glass in the rock. Some of the glass fragments form three-pronged individuals; they evidently represent partial sections of three glass bubbles which are in contact.

The rock is a volcanic ash which is partially altered and which is considerably silicified. The presence of siliceous volcanic ash concretions in a bed of bentonite suggests that the silica has hindered the alteration of the ash to bentonite.

Specimens Nos. 40, 44, 49—Volcanic Ash

FIELD OBSERVATIONS.—These represent the less altered volcanic ashes, grayer or whiter in color in the exposures and more resistant to erosion, especially R44 which forms a prominent ledge, in some instances overhanging the bentonite below.

MICROSCOPIC EXAMINATION.—Specimens are white-colored, hard and very gritty to the touch. In some instances the rock is vesicular.

MICROSCOPIC EXAMINATION.—The rocks are for the most part coarse-grained and composed mainly of fragments of volcanic glass. The fragments are usually very clear and almost colorless, but a few are dark in color and clouded with alteration material. Sometimes brown-colored glass fragments occur; they are often filled with gas bubbles. The glass fragments are very angular in shape; three-pronged or Y-

shaped fragments are common. In addition to angular fragments there are round bubble-like globules of glass. Some of the glass fragments are bent and show parallel fracture lines; in such instances some of the contorted fragments become partially anisotropic. The matrix of the glass fragments is a yellowish-brown colored substance which is almost all isotropic. There is also a development of dark green to almost black chloritic material. There is no evidence of development of a highly birefringent mica like that developed in the bentonitic rocks. Throughout the rock there are scattered a few irregularly shaped fragments of quartz and acid plagioclase.

The rock is a volcanic ash, or specifically a rhyolitic ash. A feature of the rock is the extensive development, in some instances, of small round pellets or concretions of volcanic material in a matrix of the same material.

Specimens Nos. 41, 42—Bentonite

FIELD OBSERVATIONS.—Although the particular samples sectioned do not seem to be very distinctive, this stratum in the field is unusual for this formation. Its color is dark gray to greenish gray, more somber than the series as a whole, and it is thin-bedded in contrast to the very massive character of most strata. It has a distinctly sandy feel and appearance and in places contains volcanic pebbles. Although without cross-bedding, it appears to be a stream or shallow water deposit.

MICROSCOPIC EXAMINATION.—These rocks are in general light-colored and fine-grained, but due to inclusions of dark fragmentary material, they sometimes appear dark and coarse-grained.

MICROSCOPIC EXAMINATION.—In thin sections the rock is light brown in color. The fragments of dark volcanic material are opaque. The main constituent of the rock is montmorillonite; the alteration of volcanic glass to montmorillonite is almost complete, with the result that no definite ash structure is visible. Acid feldspar fragments, i. e., both orthoclase and acid plagioclase, are abundant throughout the rock. The presence of this abundant feldspar probably accounts for the sandy appearance of the formation in the field.

Specimen 45—Bentonitic Ash

FIELD OBSERVATIONS.—This is the matrix of the most abundant fossils at this locality. Not only is it richer in mammals than any other stratum or locality known as yet in the *Notostylops* Beds, but it is also unusual in that a number of specimens from it are associated parts of the skeleton, a condition very rare elsewhere. It overlies the hard ledge of R44 and grades into it in a short distance but without a really sharp contact.

MICROSCOPIC EXAMINATION.—Rock is similar in appearance to R44, but it is much finer-grained. There is a rough or ashy feel to the rock but not nearly so pronounced as in R44.

MICROSCOPIC EXAMINATION.—Thin-section study reveals many small round concretions similar to those in R44. Volcanic glass fragments are fairly common but are not nearly as abundant as in R44. Montmorillonite is developed as a network of small crystals throughout the rock. Quartz and acid plagioclase fragments are common.

Specimens R46 and 47—Bentonite

FIELD OBSERVATION.—These rocks appear to represent the still further breaking down of the original volcanic ash overlying and grading imperceptibly into R45.

MACROSCOPIC EXAMINATION.—Rock is light-colored and fine-grained. The ashy character of R45 is not usually perceptible.

MICROSCOPIC EXAMINATION.—There is an extensive development of montmorillonite. Alteration of volcanic glass is almost complete, with the result that almost no glass structure remains. There are angular fragments of acid plagioclase, albite and quartz throughout the rock.

Specimens R43 and 48—Bentonite

FIELD OBSERVATIONS.—In general these specimens represent horizons in which the alteration from volcanic ash to bentonite is complete. Note: R43 and R48, like R38, are immediately overlain by typical volcanic ash beds.

MACROSCOPIC EXAMINATION.—These are very fine-grained and very light-colored rocks.

MICROSCOPIC EXAMINATION.—Petrographic study reveals the rocks to be homogeneous in grain size and composed almost entirely of the one mineral, montmorillonite. The crystals of montmorillonite are needle-like in appearance and have no definite orientation. Fragments of quartz and acid plagioclase are present in both specimens; they are more numerous and larger in R43 than in R48.

Specimen No. 51—Concretion

FIELD OBSERVATIONS.—This is not in the same vertical section as the preceding series, but is nearby and of the same age as the upper part of the latter. It is characteristic of concretionary zones commonly occurring at one or more levels in the *Nolo-stylops* Beds. This particular bed is about eight feet thick and consists of yellow bentonite with very numerous round black concretions, of the size of a pea to that of a walnut. The bed is purely local and cannot be traced more than a few hundred feet.

MACROSCOPIC EXAMINATION.—Specimens are round concretions of very dark, fine-grained material. The dark color, almost black, of the concretions is due to the presence of a manganese mineral which is probably pyrolusite.

MICROSCOPIC EXAMINATION.—The concretions show concentric structure. A large part of the concretion is made up of pyrolusite. There is present in the concretions a small amount of montmorillonite. It is concentrated in concentric zones in the concretions.

A summary of the rock descriptions given shows that in the stratigraphic section illustrated in figures 2 and 3 there is the following sequence of rock types:

R49—Volcanic Ash

R48—Pure¹ bentonite

R46 and 47—Bentonite, contains very few remnants of ash structure

R45—Bentonite with ash structure fairly common

R44—Volcanic ash

R43—Pure¹ bentonite

R41 and 42—Bentonite, contains fragments of volcanic material but no definite ash structure

R40—Volcanic ash

R38 and 39—Nearly pure bentonite, contains concretions at certain levels

¹Pure bentonite is a descriptive term used to indicate a rock in which all remnants of ash structure are gone and one composed of montmorillonite to the exclusion of all other minerals except odd fragments of feldspar, quartz and heavy minerals.

This sequence of rocks indicates rather clearly that the bentonite is a product of the alteration of volcanic ash, since every horizon of volcanic ash grades upward into a horizon of bentonite in which there is abundant evidence of ash structure and of volcanic glass altering to montmorillonite, and this in turn grades upward into a horizon of bentonite in which all evidence of ash structure is destroyed and the rock is composed almost entirely of montmorillonite. The evidence supporting this origin for the bentonite is further strengthened by the fact that the bentonite contains the same variety and quantity of minerals such as quartz, feldspar, and heavy accessory minerals as the volcanic ash.

An additional fact that is clearly brought out in the sequence is the gradational character of the contact between volcanic ash and bentonite on the upper side of an ash bed, whereas in contrast the ash bed itself rests on bentonite with no gradational relation.

SECTION SOUTH OF LAGO COLHUÉ-HUAPÍ

The classic section in the great barranca south of Lake Colhué-Huapí—see Figure 1—has continuous exposures with *Notostylops*, *Astraponotus*, *Pyrotherium* and *Colpodon* Beds superposed (see Fig. 4). The general character of these rocks is similar to that of the shorter and more detailed section in Cañadón Vaca already given, but a few further notes on particular samples from this section are given.

Specimen No. R11—Basalt

FIELD OBSERVATION.—In this area the lava flows are by no means continuous, but appear as lenses in the section, apparently representing tongues of lava filling shallow valleys.

MACROSCOPIC EXAMINATION.—Rock is a medium-grained, weathered igneous rock; it is vesicular with clayey material filling the vesicles.

MICROSCOPIC EXAMINATION.—Rock is felsitic in texture with occasionally an ophitic relation between feldspar and pyroxene. It is composed almost entirely of basic plagioclase feldspar, augite, brown mica and brown hornblende. The feldspars are lath-shaped and are plagioclase of labradorite composition. Augite is present in euhedral crystals and in forms without definite crystal shape. Hornblende is present in small quantity in the form of basaltic hornblende. There is considerable brown mica present.

The rock is an auganite or as more commonly stated a basalt.

Specimen No. R12—Bentonite

FIELD OBSERVATION.—This rock has the characteristic field appearance of a typical bentonite, like those of Cañadón Vaca, but is here of special interest as it intervenes between the extrusive basic rock and the immediately overlying hardened but less bentonitic scarp formed by rocks like the next one described—R27.

MACROSCOPIC EXAMINATION.—Rock is very fine-grained, compact with slippery feel, light brownish-yellow color. It is a typical bentonite

MICROSCOPIC EXAMINATION—Thin section study shows the rock to be made up of very tiny crystals of montmorillonite; the crystals have no definite orientation; there is a marked tendency for more extensive development of montmorillonite along the borders of fracture in the rock. The fracture network of the rock is quite extensive. There is at least one prominent band in the specimen in which extensive development of large crystal aggregates of montmorillonite have taken place; it evidently represents an original large fracture along which the alteration of the original rock to bentonite was best able to proceed. There is present throughout the rock a sufficient number of irregular-shaped fragments of volcanic glass and of glass partially altered to montmorillonite to show that the rock was originally a volcanic ash. A very few acid feldspar and quartz fragments are present.

NOTE:—Professor Kerr finds that the X-ray diffraction patterns of a sample of this material agree with those given by members of the montmorillonite group.

Specimen No. R27—Volcanic ash

FIELD OBSERVATIONS.—This is typical of the rock frequently occurring in Lower Tertiary sections in Patagonia and by Ameghino called "tosquilla." It is gray when unweathered, but often becomes yellow to orange on weathered surfaces. It may be very hard and is usually strongly resistant to weathering, so that it forms benches and vertical or even overhanging scarps. It is very porous and highly vesicular on weathered surfaces. In places it appears to be largely composed of rolled volcanic ash balls, in others to be concretionary, but these two conditions are not easily distinguished. It often contains fossils, but these are sparsely scattered through it and usually rolled and very incomplete. This specimen is from the thickest "tosquilla" series of this section, at and below the base of the *Colpodon* Beds, but other thinner beds of identical nature occur at lower levels in the same section and they may occur at any Lower Tertiary horizon. In some cases they grade laterally into ordinary gray volcanic ash

MACROSCOPIC EXAMINATION.—It is a hard ash rock, very rough and gritty to the touch.

MICROSCOPIC EXAMINATION.—Rock is composed largely of fragments of volcanic glass. The fragments are very irregular in shape; some exhibit good conchoidal fracture, and they are evidently broken glass bubbles. In some instances the glass fragments grade over into the light-brown colored micaceous mineral montmorillonite. This development of montmorillonite is very insignificant in amount, and consequently the rock exhibits none of the characters of bentonite in the hand specimens. A few fragments of acid plagioclase and quartz are present.

Rock is a volcanic ash and is similar to the other volcanic ash rocks described in this paper.

Specimens Nos. R21—R29—R32—Concretions

FIELD OBSERVATIONS.—These represent two types of concretions very abundant in the Tertiary tuffs. All are from the same great exposure south of Lago Colhué-

Huapí. Locally concretions may characterize a given horizon, but considering the central Patagonian formations as a whole, they may be of almost any age. R21 and R32 are characteristic of layers of spherical concretions, often in the "tosquilla" (R27) or other relatively unaltered volcanic ash, to which they may give the appearance of a conglomerate. They are nearly always spherical and in numerous cases have a small round depression on one side, like the stem attachment of a fruit. R29 is typical of the common siliceous concretions, present in great number and variety.

MACROSCOPIC EXAMINATION.—R21 and R32 are concretions of light-brown colored, very hard volcanic material; they are spherical in shape and are hollow; they have a rather crude concentric structure, i e., they tend to break apart like a shell from a nut. The concretions range in size from $\frac{1}{8}$ " in diameter to $1\frac{1}{2}$ ". Silicification of the concretions has made them quite hard.

R29 is a geode rather than a concretion; it is composed of chalcedony, quartz, and opal.

MICROSCOPIC EXAMINATION.—R21 and R32 are very dark brown in color in the thin section and transmit very little light. The rock is composed mainly of fragments of volcanic glass. The fragments vary greatly in size and shape; there is, however, a tendency for a concentration of round glass bubbles toward the inside of the concretion. The outer rim of each glass bubble is altered to brown-colored montmorillonite. Small angular fragments of quartz and feldspar are scattered throughout the rock. Most of the matrix of the glass fragments is a dirty-brown isotropic volcanic material—this is especially true of the outer part of the concretion; the inner part, close to the hollow center, has a matrix of montmorillonite. An interesting feature of the concretions is the fact that the central zone gives a rapid swelling reaction when placed in water, whereas the outer zone does not. This feature is evidently due to the presence of montmorillonite in the interior of the concretions and to its absence in the outer part. The fact that the montmorillonite is developed in the interior of the concretion rather than at the exterior seems difficult to explain, especially in view of the fact that in this study it is usual to find volcanic ash grading upward into bentonite. It may be that the outer zones of the concretions represent material added since the alteration on the inside took place, or as in the case of other concretions—e g., R39—described in this paper, the alteration of volcanic glass to montmorillonite is probably hindered by the introduction of silica, and since the outer zones of the concretions are more silicified than the inner, they are the least altered to montmorillonite.

R29. Thin section of a geode shows the presence of quartz, chalcedony and opal. Quartz crystals radiate from a common point to form a circular mass; these in turn pass into finely crystallized quartz or into radiating chalcedony fibers. Every quartz grain seems to serve as a nucleus for chalcedony. The chalcedony makes up over one-half of the rock. Scattered through the rock are both large and small masses of opal.

The interior of the geode is lined with tiny stalactites of quartz surrounded by chalcedony.

COMMERCIAL ASPECT OF THE BENTONITE

There is available a tremendous supply of bentonite in this region, enough to supply any conceivable world market for centuries. A large

amount is within short wagon-haul of sea transportation at or near Comodoro Rivadavia (see Fig. 1) and a still greater amount along the railway to Colonia Sarmiento. Even Comodoro, however, is so far from any important present or probable future market that this makes much commercial development improbable. A limited amount can no doubt be used in local oil refineries, but this can hardly assume the proportions of an independent industry.

LATE TERTIARY AND QUATERNARY
(here relatively unimportant)

Patagoniano-Marine, probably late Oligocene or Miocene	
Terrestrial Tuffs, with at least four distinct mammalian faunas of Tertiary aspect.	<i>Colpodon</i> beds (perhaps in part equivalent to the lower Patagoniano).
	<i>Pyrotherium</i> beds
	<i>Astraponotus</i> beds
	<i>Notostylops</i> beds
"Argiles fissilaires," local, non-fossiliferous, of doubtful age and relationships	
Chiefly sandstones and clays, not subdivided by previous work. The "Pehuenche" or "upper beds with dinosaurs" of most recent authors, not the Pehuenche of Ameghino in this region.	
Salamanqueano-Marine, probably Senonian, surely Cretaceous.	

Very thick and varied continental deposits, the Chubutiano of some recent authors, variously but not yet definitively subdivided. Containing dinosaurs and partly or wholly Cretaceous.

Fig. 4.—Preliminary table of the late Cretaceous and early Tertiary formations of central Patagonia. (After Simpson, Amer. Mus. Novitates, No. 566, p. 4.)

NOTE ON GLAUCONITE ABOVE THE SALAMANQUEANO

The accompanying diagram (Fig. 4) will help to make clear the stratigraphic sequence involved in the preceding sections. The bearing of these petrologic notes on the general stratigraphic problems is to some extent suggested here and will be further discussed in forthcoming work

by Simpson. The present author also plans a later study of the petrology of the so-called "argiles fissilaires," which constitute one of the most puzzling features of Patagonian stratigraphy. Although they do not relate directly to the bentonitic rocks, there are here added observations on a discovery of considerable interest made in the course of the present study.

In central Patagonia the only surely recognized Mesozoic marine formation is the Salamanqueano, apparently of Senonian age. This invasion came from the east and is represented by a wedge of rocks, thick near the coast and thinning out and tending to lose its marine character to the westward. Without going into more stratigraphic detail here, the upper part of this marine formation is usually represented by the so-called Banco Verde, a glauconitic sand of marine to estuarine origin. Above this there is usually a black clay, the so-called guide horizon or Banco Negro, in part of transitional character but generally accepted as the base of a continental late Cretaceous series. Above this is a series of sands and clays, generally but (according to Simpson) erroneously called Pehuénche. The upper part of this series is of Tertiary age. The lower part is probably in places really late Cretaceous, although the lithologic resemblance makes the contact difficult or impossible to establish in most instances.

An unexpected result of this petrographic study is the recognition of glauconitic sandstones in this so-called Pehuénche, well above the Banco Verde and Banco Negro, but still below the known Tertiary mammal-bearing horizons. The most important instance is that of the round hill northwest of Puerto Visser (see Fig. 1); there glauconitic sandstone occurs 45' above the Banco Verde, about 30' above the Banco Negro, and 75'-80' below the lowest Tertiary mammals. The evidence suggests that marine and semi-marine conditions continued here longer than has previously been supposed and that there is a still undefined transitional late Cretaceous division here between the accepted Salamanqueano and the mammal-bearing sandstones of the so-called "Pehuénche." Secondary derivation of the glauconite from the Banco Verde is possible, but appears improbable.

Specimen No. R110

FIELD OBSERVATION.—See above.

MACROSCOPIC EXAMINATION.—Rock is a green-colored soft sandstone. It is homogeneous without evidence of good bedding.

MICROSCOPIC EXAMINATION.—In thin section, the green mineral which gives the rock its color is recognized as glauconite. The mineral is present in well rounded

grains. The cementing medium of the glauconite grains is a light-brown colored mineral, probably some form of altered glauconite. The brown material is almost entirely isotropic. The glauconite grains are typically deep green in color and are almost isotropic. Scattered throughout the rock are numerous irregular-shaped fragments of quartz and feldspar; the feldspar is a plagioclase of labradorite composition.

Another instance, less important because the stratigraphic sequence is not positively established, is of a green sandstone in Cañadón Hondo (see Fig. 1), quite evidently higher than the recognized Salamanqueño and in the so-called Pehuénche. Its relationship to the mammal-bearing sandstones of Cañadón Hondo is not clear, but it is probably somewhat older.

Specimen No. R68

FIELD OBSERVATIONS.—See above.

MACROSCOPIC EXAMINATION.—Rock is a pale-green colored, fairly coarse sandstone which is cemented with calcium carbonate.

MICROSCOPIC EXAMINATION.—The sandstone is composed of detrital grains of glauconite, quartz and feldspar. Calcite is the cementing medium, and it is the most abundant constituent of the sandstone. The green color of the rock is due to the presence of glauconite. The glauconite is present in deep green rounded grains and green and brown irregular-shaped grains.

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FOUR NEW SPIDERS OF THE FAMILY GNAPHOSIDAE

BY RALPH V. CHAMBERLIN

Through the courtesy of W. J. Gertsch, of The American Museum of Natural History, I have had the opportunity of examining two collections of Gnaphosidae, one largely from Minnesota, made chiefly by Mr. Gertsch himself, and the other from Alberta, Canada, constituting part of a general collection of spiders placed in his hands for identification.

The gnaphosids from the first collection, from Minnesota unless otherwise noted, prove to be as follows:

Herpyllus vasifer (Walckenaer)
Herpyllus hesperolus Chamberlin (Yosemite Park, Cal.)
Sergiolus variegatus (Hentz)
Gnaphosa gigantea Keyserling
Gnaphosa parvula Banks
Gnaphosa brumalis Thorell (Figs. 1 and 2)
Drassodes neglectus (Keyserling)
Drassodes robinsoni Chamberlin
Haplodrassus magister, new species
Haplodrassus signifer (C. Koch)
Drassyllus niger (Banks)
Drassyllus transversus (Emerton)
Zelotes subterreaneus (C. Koch) (Minnesota and Montana)

The specimens from Alberta, Canada, are as follows:

Callilepis imbecilla (Keyserling)
Gnaphosa gigantea Keyserling
Gnaphosa brumalis Thorell
Gnaphosa mimia, new species
Gnaphosa parvula Banks
Callilepis imbecilla (Keyserling)
Drassodes neglectus (Keyserling)
Haplodrassus signifer (C. Koch)
Haplodrassus allanus, new species
Orodassus coloradensis (Emerton)
Orodassus vastus (Banks)
Zelotes subterreaneus (C. Koch)
Zelotes puritanus Chamberlin

The new species indicated are described below, together with a new *Gnaphosa* from Utah noted in the course of the present study. All of the species of *Gnaphosa* herein listed, or described, belong in a group to which this name should be restricted. Various other western species heretofore placed in *Gnaphosa* constitute a natural generic group which I here propose to designate as **CYLPHOSA** with *Gnaphosa gosoga* Chamberlin as the genotype. They are characterized especially by the obviously different palpal organ in which the very long style arises on the apical or ectal side of the bulb and coils loosely about the bulb one or more times. The apical apophysis is distally slender and pointed and characteristically membranous proximally.

***Gnaphosa mimia*, new species**

Figures 3 and 4

MALE.—Integument of carapace and sternum dark brown, with a fine network of black lines over lateral portion of pars cephalica and in stripes running from the stria thoracica to lateral margins; the chelicerae and legs brown. Carapace clothed with whitish hairs closely appressed to surface and with very sparse, erect and long black hairs. Abdomen with a dense coat of fine, plumose brown hair and with numerous long, evenly spaced and erect black bristles, showing no color pattern; ventrally the abdomen appears paler in front of the genital furrow because of the absence of the dense coat of hair there.

All tarsi scopulate throughout length, the anterior metatarsus scopulate distally, the posterior metatarsi not scopulate. Metatarsi I and II with a pair of stout ventral spines. Ventral spines of tibia I, 1-2-2; of tibia II, 1-2-2, or 2-2-2. Tibias III and IV with a spine at base on mid-dorsal line.

Cephalothorax low, the posterior portion of pars cephalica on a level with pars thoracica, slanting down moderately in front of middle; pars cephalica relatively narrow. Chelicerae moderately geniculate. Posterior row of eyes strongly recurved, the median eyes about their radius apart, approximately their diameter and a half from the laterals. Area of median eyes as long as wide posteriorly, a little narrower in front than behind (6:7). Anterior row of eyes procurved as usual, much shorter than the posterior row (4:3), the median eyes much smaller than the laterals.

Distinct in form of tibial apophysis and details of male palpal organ, as shown in the figures.

Measurements

Length of cephalothorax, 3.3 mm ; width, 2.9 mm

Legs:	I	II	III	IV
Coxa-trochanter	1.8	1.8	1 2	1 8
Femur	2.3	2 1	2 0	2 3
Tibia-patella	3.0	2.7	2 2	2 8
Metatarsus	1 8	1.5	1 7	2.8
Tarsus	1 2	1.1	1 2	1 2
TOTAL	10 1 mm	9.2 mm.	8 3 mm	10 9 mm.

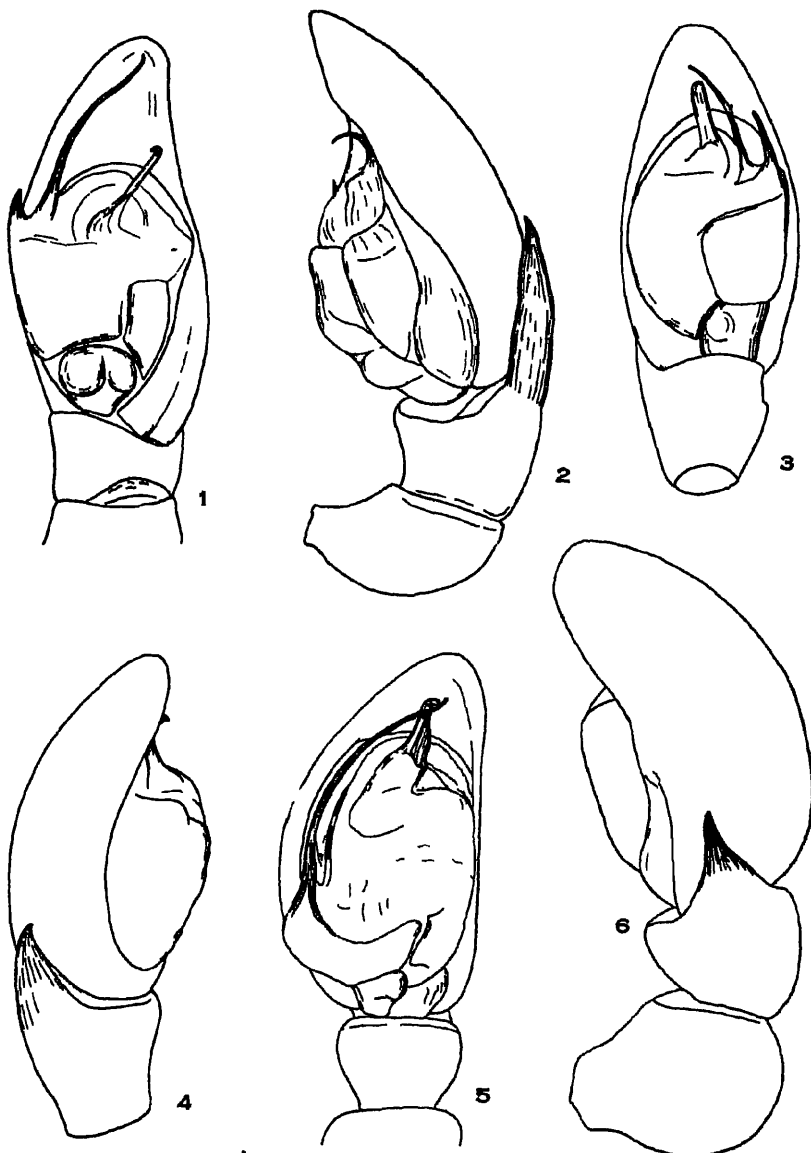


Fig. 1. *Gnaphosa biunahs* Thorell. Left palp of male, ventral view.
 Fig. 2. The same, ectal view.
 Fig. 3. *Gnaphosa mima*, new species. Right palp of male, ventral view.
 Fig. 4. The same, ectal view.
 Fig. 5. *Gnaphosa antipola*, new species. Left palp of male, ventral view.
 Fig. 6. The same, ectal view.

LOCALITY.—Canada: Seba, Alberta; June 1–July 6. Two males (holotype and paratype) in the collection of The American Museum of Natural History.

***Gnaphosa antipola*, new species**

Figures 5, 6, and 7

Carapace brownish black, the black being more condensed on head bordering the cephalothoracic furrow, along radiating furrow of thorax and along lateral borders. Sternum nearly black. Legs also black but with two last articles paler. Cephalothorax and legs clothed with the usual black hairs, the paler plumose hairs not conspicuous. Abdomen in the types appearing nearly black, clothed with the usual black hairs and setae and the fine appressed and paler plumose ones. The female allotype has cephalothorax and legs lighter in color.

Tarsi I and II entirely, and metatarsi I and II to their middle densely scopulate beneath, the posterior tarsi and metatarsi not at all scopulate. Tibia I in the male holotype is armed beneath with 1–1–2 spines, tibia II with 1–2–2 spines. Metatarsi I and II bearing one pair of ventral spines. Tibiae I and II in the female allotype bear beneath only 0–0–1 spines. Tibiae III and IV with a stout mid-dorsal spine at base.

Eyes typical in general arrangement and spacing. Anterior median eyes much smaller than the laterals (about as 7:10). Area of median eyes scarcely longer than wide, equal in width anteriorly and posteriorly. Posterior median eyes small, circular, about five-sixths their diameter apart and close to one and two-thirds times their diameter from the laterals.

Character of palpus as shown in the figures.

Measurements

MALE

Total length, 8 mm.

Length of cephalothorax, 4 mm.; width, 3 mm.

Legs:	I	II	III	IV
Coxa-trochanter	1 9	1 8	1 8	2 0
Femur	2 9	2 3	2 0	3 0
Tibia-patella	3 2	2 9	2 5	3 2
Metatarsus	1 8	1 8	2.0	2 7
Tarsus	1 5	1 2	1 2	1 8
TOTAL	11 3 mm.	10 0 mm	9 5 mm.	12 7 mm.

FEMALE

Total length, 8 mm.

Length of cephalothorax, 4.1 mm ; width, 3 mm.

Legs:	I	II	III	IV
Coxa-trochanter	1 8	1 7	1 7	2 0
Femur	2 6	2 2	2 0	2 8
Tibia-patella	3 0	2 9	2.6	3 2
Metatarsus	1.3	1 5	1.9	2 7
Tarsus	1.2	1 1	1.2	1 3
TOTAL	9 9 mm.	9.4 mm	9 4 mm.	12.0 mm

LOCALITY.—Utah: Utah County, west shore of Utah Lake, October 15, 1931; male (holotype), female (allotype), and an immature male; collector, W. Ivie; in collection of the University of Utah.

***Haplodrassus altanus*, new species**

Figures 8, 9, and 10

MALE.—Carapace and chelicerae light brown, the former with black lines running a short distance forward from region of median furrow along each side of pars cephalica and along the middle of the latter, the surface clothed sparsely with suberect dark hairs, and with more numerous appressed whitish hairs. Sternum similar in color to carapace, dusky laterally, clothed with more numerous erect dark hairs. Legs dull brownish-yellow. Abdomen dark brownish-gray, clothed with long dark suberect hairs and more densely with finer appressed and mostly lighter brown hair.

Legs with numerous stiff dark hairs and shorter pale ones, as usual. Leg one with femur and with two long seriate spines in dorsal line, two closer together toward distal end on anterodorsal surface; other joints unarmed excepting for a single ventral spine at base of metatarsus. Tibia II also unarmed, metatarsus II having a pair of ventral spines at base. Legs III and IV with numerous spines as usual, the tibiae with none in median dorsal position.

Cephalothorax low, the dorsal line nearly horizontal, the pars cephalica not elevated, broad, the head region relatively wide.

Anterior row of eyes procurved, the eyes nearly equal in size, the medians about their diameter apart and less than their radius from the laterals. Posterior row of eyes gently procurved, longer than the anterior row by nearly twice the diameter of a posterior lateral eye; median eyes oblong, set very obliquely to each other, their long diameter from the much smaller lateral eyes but less than half as far from each other. Area of median eyes a little wider in front than behind and nearly of same length as the anterior width. Anterior lateral eyes about their diameter from lower margin of clypeus. Chelicerae with armature typical except that in the holotype there is but a single tooth below on the right chelicerae, this being larger than usual; that of the other chelicerae normal.

Distinct in the form of the tibial apophysis of the palpus, this being laminate, rather short, and abruptly narrower distally as shown in the figure. Other features as figured.

FEMALE.—Coloration in general as in the male, but the abdomen above showing an obscure pattern of lighter marks as follows: a median basal mark on each side close to and parallel with it a mark vaguely broken into spots; behind the basal mark a series of chevrons scarcely detectable.

Femur of leg I with two seriate spines above and a single spine at distal end on anterodorsal surface; other joints wholly unarmed. Metatarsus II with two ventral spines at base as in the male holotype.

The cephalothorax similar in form but the head in eye region more depressed or slanting forward. Lower margin of chelicerae with two distal teeth.

Eye relations nearly as in the male, the anterior median eyes smaller than the laterals. Area of median eyes as broad posteriorly as anteriorly.

Epigynum as figured.

Measurements

FEMALE

Length, 9 mm

Length of cephalothorax, 3.8 mm; width, 3 mm.

Legs:	I	II	III	IV
Coxa-trochanter	2.0	1.8	1.5	2.0
Femur	2.8	2.1	2.0	3.0
Tibia-patella	3.3	3.0	2.1	3.1
Metatarsus	1.2	1.1	1.0	2.0
Tarsus	1.0	1.0	1.0	1.2
<hr/>				
TOTAL	10.3 mm.	9.0 mm	7.6 mm	11.3 mm.

MALE

Length, 6 mm.

Length of cephalothorax, 3 mm.; width, 2.2 mm.

Legs:	I	II	III	IV
Coxa-trochanter	1.5	1.1	1.0	1.5
Femur	2.4	2.0	1.6	2.5
Tibia-patella	3.0	2.6	2.0	3.0
Metatarsus	1.5	1.1	1.1	1.8
Tarsus	1.1	1.0	0.8	1.0
<hr/>				
TOTAL	9.5 mm	7.8 mm	6.5 mm.	9.8 mm

LOCALITY.—Canada: east of Fitzgerald, Alberta; 1930; one male (holotype) and one female (allotype); collector, H. S. Hicks; in the collection of The American Museum of Natural History.

Haplodrassus magister, new species

Figures 11 and 12

MALE.—Carapace, sternum, and chelicerae light chestnut, the first pairs of legs similar or much paler distally, the last two pairs yellowish. Carapace with sparse dark hairs, the sternum with more numerous straight erect black hairs, which are denser along the borders. Abdomen with integument whitish with a light chestnut scutum at base above, clothed with numerous dark hairs but apparently less dense than that coat of appressed hair present in *H. altanus*, the rubbed condition of specimen making accurate judgment of this impossible.

Legs clothed with long stiff and suberect setae of dark color but with few finer appressed ones. Tarsus scopulate as usual but the scopulae not very dense; anterior metatarsi scopulate except at base, the posterior metatarsi scopulate only over apical region. Femur of leg I with two seriate spines above and one on anterior face distad of middle; femur II with two spines above and two on anterior face. Tibia and metatarsus I unarmed. Tibia II with ventral spines 1-1; metatarsus II with a pair of spines at base and a single median one. No mid-dorsal spines on tibiae III and IV.

Anterior row of eyes procurved in the usual degree; the median eyes somewhat smaller than the laterals, not fully their diameter apart and less than their radius

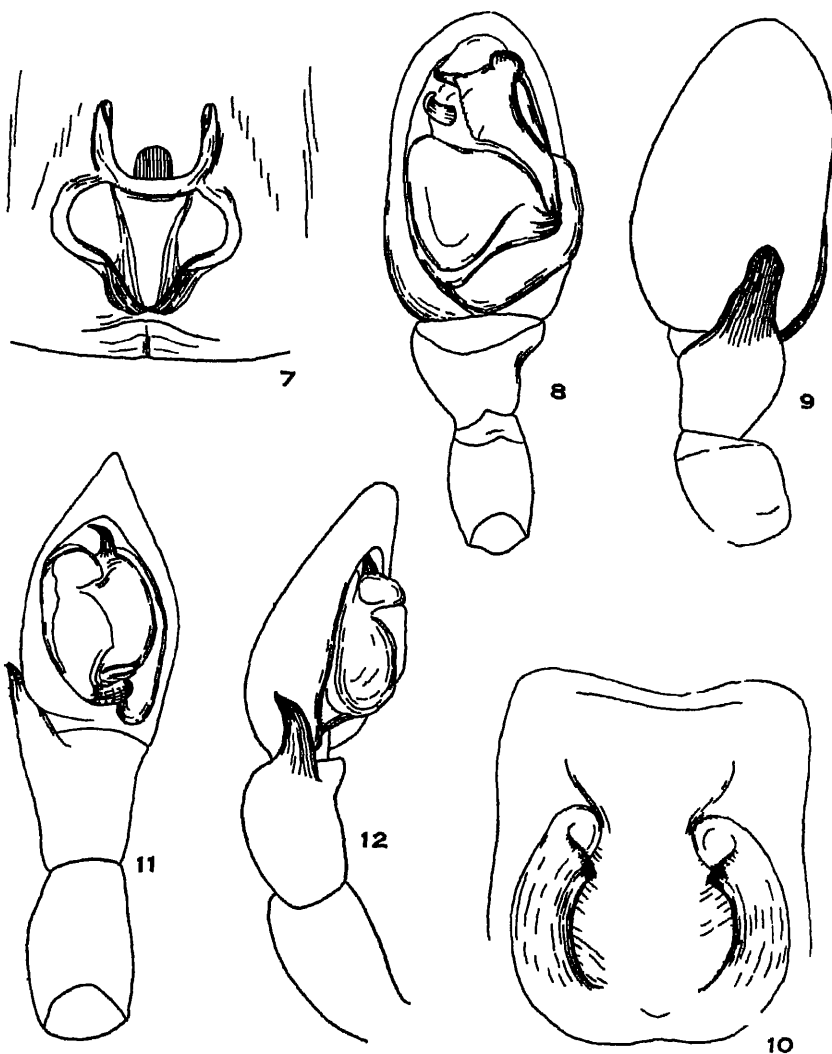


Fig 7 *Gnaphosa antipola*, new species Epigynum of allotype
 Fig 8 *Haplodrassus altanus*, new species Right palpus of male, ventral view
 Fig 9 The same, ectodorsal view
 Fig 10 *Haplodrassus altanus*, new species Epigynum of allotype
 Fig 11 *Haplodrassus magister*, new species Right palpus, ventral view
 Fig 12 The same, ectal view

from the laterals. Posterior row of eyes considerably procurved, only slightly longer than the anterior row; median eyes very large, their long diameter exceeding the diameter of a lateral one in about ratio 5:3, oblique, almost contiguous with each other, less than their radius from the laterals; lateral eyes less than their diameter from the anterior laterals. Area of median eyes wider behind than in front in about ratio of 5:4, the length nearly equal to the anterior width. Armature of chelicerae typical.

Tibial apophysis and features of palpal organ of male palpus as shown in the figures.

Measurements

Total length, 8 mm				
Length of cephalothorax, 3.9 mm; width, 2.9 mm.				
Legs:	I	II	III	IV
Coxa-trochanter	2.2	1.8	1.5	2.0
Femur	4.0	2.8	2.0	3.2
Tibia-patella	4.4	3.3	2.9	4.6
Metatarsus	2.2	2.0	1.9	3.4
Tarsus	1.8	1.3	1.2	1.8
TOTAL	14.6 mm.	11.2 mm.	9.5 mm.	15.0 mm.

LOCALITY.—Minnesota: Minneapolis; June, 1931; one male (holotype); collector, W. J. Gertsch; in the Collection of The American Museum of Natural History.

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A SKULL AND MANDIBLE OF *GIRAFFOKERYX* *PUNJABIENSIS* PILGRIM

By EDWIN H. COLBERT

The genus *Giraffokeryx* was founded by Dr. G. E. Pilgrim to designate a primitive Miocene giraffe from the lower Siwalik beds of northern India. Doctor Pilgrim, in a series of papers,¹ described *Giraffokeryx* on the basis of fragmental and scattered dentitions. Naturally, Pilgrim's knowledge of the genus was rather incomplete, and he was unable to formulate any opinions as to the structure of the skull or mandible.

An almost complete skull, found in the northern Punjab in 1922 by Mr. Barnum Brown of the American Museum, proves to be that of *Giraffokeryx*, and it exhibits such striking and unusual characters that a separate description of it has seemed necessary. This skull, together with numerous teeth and a lower jaw, gives us a very good comprehension of the genus which forms the subject of this paper. The drawings of the skull were made by John C. Germann, and the remaining ones were done by Margaret Matthew.

MATERIAL DESCRIBED

Only the material referred to in this description will here be listed. There are a great many specimens of *Giraffokeryx* in the American Museum collection, but since most of them are teeth, they will not be considered at this time. A subsequent paper, dealing with the American Museum Siwalik collection in detail, will contain a complete list of the *Giraffokeryx* material.

Amer. Mus. No. 19475.—A skull, complete back of the muzzle. The cheek teeth are preserved on both sides. The skull has been crushed to some extent. From the lower portion of the Middle Siwaliks, 1,000 feet below the Bhandar bone bed,² and one mile south of Nathot in the Punjab.

Amer. Mus. No. 19611.—Unassociated teeth. Lower Siwaliks, 200 feet above the level of Chinji Rest House and four miles west of that location, Punjab

¹Pilgrim, G. E. 1910. 'Notices of New Mammalian Genera and Species from the Tertiaries of India.' *Rec. Geol. Surv. India*, XL, Pt. 1, p. 69.

1911. 'The Fossil Giraffidae of India.' *Mem. Geol. Surv. India, Pal. Indica, N.S.*, IV, No. 1, pp. 14-17; Pl. I, figs 4, 5, Pl. II, figs 1-18.

²The Bhandar bed was named by Pilgrim, from the village of Bhandar in the Jhelum district, Rawalpindi division of the northern Punjab. He considered this as an unfossiliferous horizon, but Brown, in 1922, opened a mixed quarry at this level, which yielded characteristic middle Siwalik fossils. The quarry was located one half mile north of Bhandar village. For the original designation of this horizon the reader is referred to Pilgrim, G. E. 1913. 'Correlation of the Siwaliks with Mammalian Horizons of Europe.' *Rec. Geol. Surv. India*, XLIII, Pt. 4, p. 277, Pl. xxxvi.

Amer. Mus. No. 19472 —A right maxilla, with P^2-M^3 . Lower portion of the middle Siwaliks, 1,200 feet below the Bhandar bone bed and one mile south of Nathot.

Amer. Mus. No. 19587 —The right ramus of a mandible, containing P_2-M_3 . Lower Siwaliks, 200 feet above the level of Chinji Rest House and one and one half miles north of that place.

It may be seen from the above list that *Giraffokeryx punjabiensis* extends through the lower Siwaliks into the lower portions of the middle Siwaliks.

MORPHOLOGY OF THE SKULL

The skull of *Giraffokeryx* represents an animal of medium size and of peculiar form. As restored, it would measure some 500 millimeters in length, which though of fair size for the general run of ruminants, is small for the giraffes. The most striking features of this skull are the four horn cores, an anterior and a posterior pair, the former rising from the forward extremities of the frontals, and the latter from broad bases that rest partly on the frontals and partly on the parietals. The anterior horn cores spring from a common base, which is located above the first and second molars (perhaps it might be better to say that they are confluent at their bases), and they diverge laterally at an angle of approximately 105 degrees. These horn cores are directed posteriorly to a very slight extent, about 15 degrees. The posterior horns are widely separated basally. They arise directly back of the orbits, diverging laterally at an angle of approximately 80 degrees. Moreover, these horn cores are directed backwardly to an extent such that, as seen from the side, their median axes make angles of about 30 degrees with the perpendicular. These posterior horn cores are somewhat convex along their anterior borders, and at their bases, both on the anterior and the posterior edges, there are large rugose protuberances, as if in life there were basal accessory knobs or branches. Due to the great backward growth of these horn cores, their bases form a partial roof over the temporal fossae.

The true homologies of the "horn cores" of *Giraffokeryx* have been very perplexing, because since the skull is that of an old animal, the sutures are ankylosed to an extent that they have been largely obliterated. By a microscopic examination the naso-frontal suture has been established just anterior to the base of the front horn cores. The frontal-parietal suture can not be definitely located, but it would seem to cross the skull at a point about opposite the median portion of the posterior horn cores. The posterior horn cores of *Giraffokeryx* are therefore quite homologous with the similar structures in *Palaeotragus* and *Samotherium*, Asiatic Miocene and Pliocene giraffes, characterized by one pair of well

developed supraorbital horn cores. But the anterior pair in *Giraffokeryx* are without homologues among any of the Giraffidae, and must therefore be considered as neomorphic structures

Of course there is a superficial resemblance between the skull of *Giraffokeryx* and that of the North American genus, *Syndyoceras*, because in both of these forms there are two pairs of horns, one pair being approximately supraorbital, while the other pair is placed above the muzzle. The resemblances between these genera are, however, attributable to functional analogies rather than to homologies, because while the

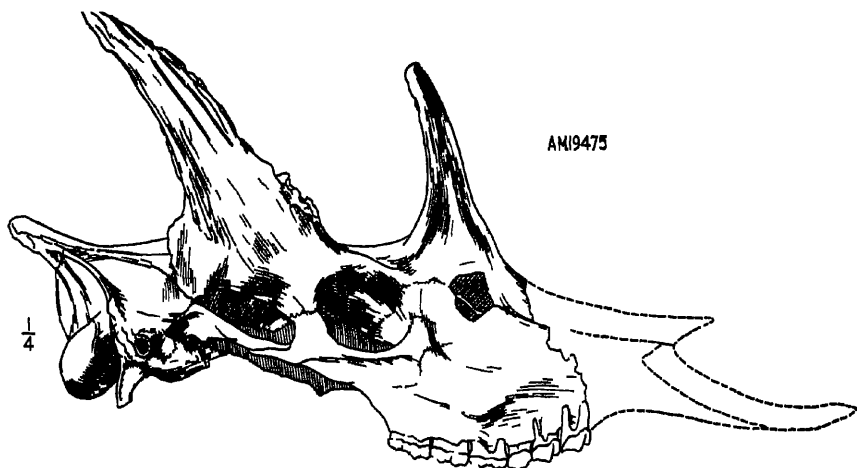


Fig. 1.—*Giraffokeryx punjabiensis* Pilgrim. Amer. Mus No. 19475 Skull, right lateral view. Restored muzzle based on comparisons with *Palaeotragus* and *Okapia*. One-fourth natural size

anterior horns are frontal upgrowths in *Giraffokeryx*, they are derived in *Syndyoceras* from the premaxillaries. In both genera the posterior horns are more nearly homologous, being frontal in *Syndyoceras*, and *fronto-parietal* in *Giraffokeryx*. Otherwise the skulls and dentitions show the taxonomic separateness that would be expected in these genera, for the Siwalik form belongs of course to the Giraffidae, and the North American genus is a member of the Protoceratidae, families that are related in kind, but which are nevertheless quite distinct from each other. *Synthetoceras*, recently described by Stirton, shows an accentuation of the *Syndyoceras* type of skull, and these two genera are closely related to each other.¹

¹Barbour, E. H. 1905. 'Notice of a New Fossil Mammal from Sioux County, Nebraska' Neb. J. Sci. 11 Pl. 2 four names omitted. (*Syndyoceras cookei*)

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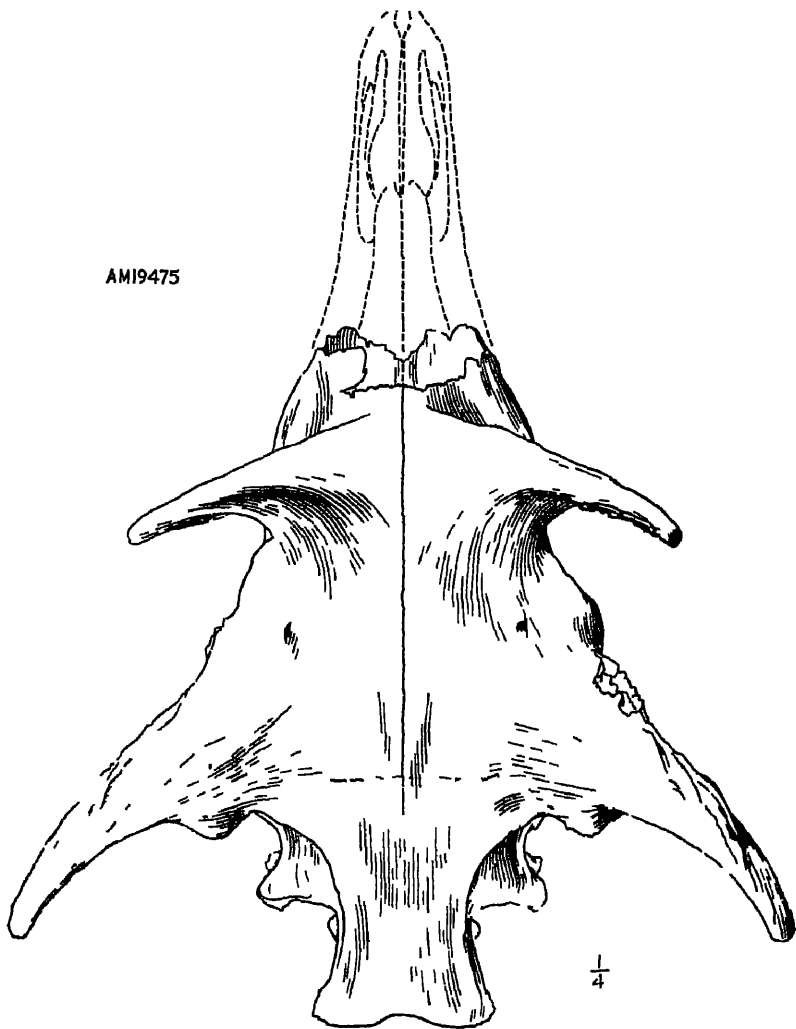


Fig. 2.—*Giraffokeryx punjabiensis* Pilgrim. Amer. Mus. No. 19475. Skull, dorsal view. Muzzle restored. One-fourth natural size.

Lankester,¹ in a series of papers, has demonstrated how in the modern okapi and giraffe, the "horns," or the *ossicones* as Lankester defined them, are developed in the skin as separated elements, becoming united with the skull as the animal approaches maturity. In the okapi, a persistent primitive form, having, like *Palaeotragus* and *Samotherium*, one pair of supraorbital horns, the ossicone coalesces with the frontal bone, and in the adult animal is firmly attached to that element. On the other hand, the ossicone in the foetal or newly born giraffe develops first above the parietal bone, but in consequence of growth factors it spreads anteriorly, so that in the adult it becomes attached to both the parietal and the frontal bones.

A growth process similar to that of the recent forms must have marked the development of the horns in *Giraffokeryx*. Indeed, the overlap of the base of each horn core on the roof of the skull is a striking character in this genus. Thus we may visualize small ossicones developing in the skin of the young *Giraffokeryx*, one pair above the anterior border of the frontals, and another pair over the back of the frontals. At maturity the front pair became attached to the frontal bones, but the posterior ossicones spread into long, elliptical bases that overlapped both the frontals and the parietals.

The nasals terminate posteriorly at the base of the front horn cores. The frontals are very wide, and extraordinarily flat, and behind them the parietals narrow rapidly and then flare out again to form the lambdoidal crest. The great constriction of the parietals in *Giraffokeryx* is an indication of the small size of the brain. The parietals dip down somewhat just behind the frontals, reaching the lowest point above the paroccipital processes, and then they rise again to the lambdoidal crest, which projects far behind the occipital condyles. There are supraorbital foramina piercing the frontals.

As seen from the side, the skull appears to be very low, an illusion caused by the crushing that it has undergone. By measuring the maxilla below the anterior horn cores, I have estimated the crushing to be about 17 per cent., so that when the skull is restored to its original height it is seen to be quite comparable to the skull of *Palaeotragus*. The basicranial axis forms a slight angle with the palatal surface.

The maxilla is heavy, with a slight swelling above the first and second molars, and the malar runs far forward on this bone. The latter forms the entire lower border of the orbit. The lacrymal is large, a

¹Lankester, E. Ray. 1907. 'The Origin of the Lateral Horns of the Giraffe in Foetal Life on the Area of the Parietal Bones.' *Proc. Zool. Soc. London*, pp. 100-115.
1907. 'The Existence of Rudimentary Antlers in the Okapi.' *Proc. Zool. Soc. London*, pp. 126-135.

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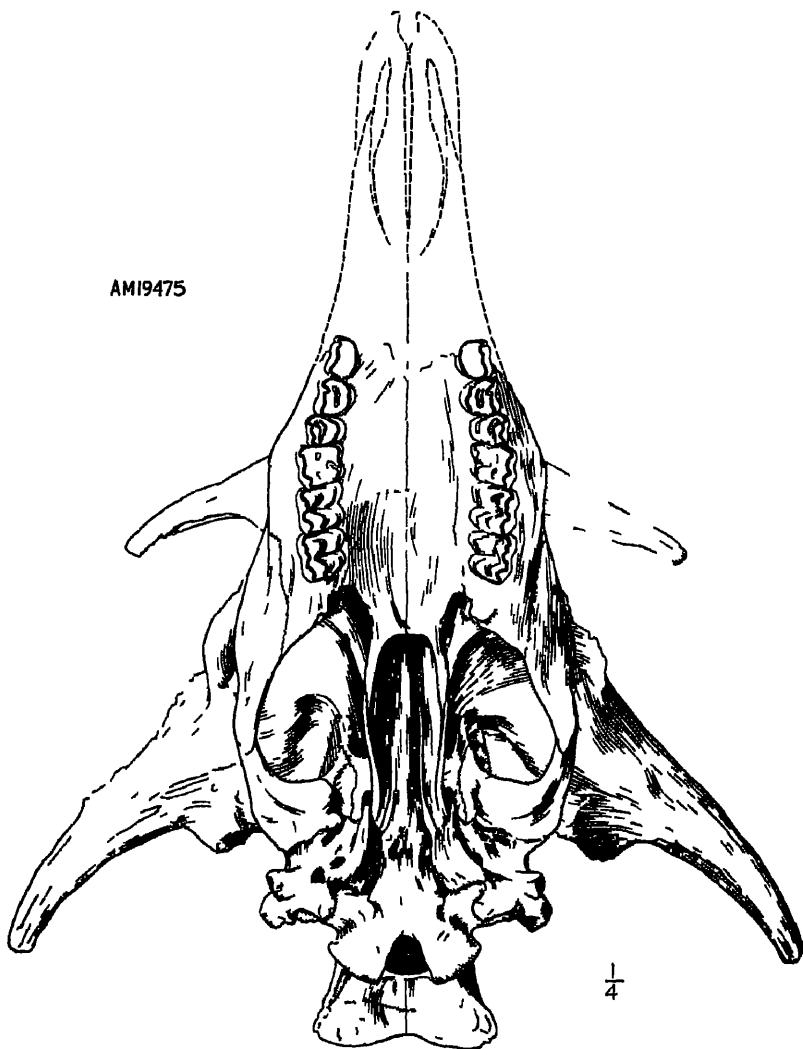


Fig. 3.—*Giraffokeryx punjabiensis* Pilgrim. Amer. Mus. No. 19475. Skull, palatal view. Muzzle restored. One-fourth natural size.

portion of it being within the orbit, and a larger portion extending forward on the side of the face. Where the lacrymal, malar and jugal meet there is a large preorbital vacuity, a characteristic feature of the giraffids. It would appear as if the trigeminus nerve traversed a maxillary sinus cavity, as in the recent giraffes.

The orbit is large, and is closed by a postorbital bar. Behind the orbit the large base of the posterior horn core projects out and back, so that it forms a heavy shelf or roof over the temporal fossa. The zygomatic arch is relatively small, and it is overhung by the base of the horn core.

Behind the glenoid is an expansion of the squamosal, carrying the tube of the external auditory meatus, and a ridge connects this expanded bone with the lambdoidal crest. Below the external auditory meatus is the paroccipital process, a fairly short but heavy structure. The occipital condyles are quite large, which would indicate that the cervical vertebrae were heavy. The supraoccipital is constricted above the foramen magnum, but it flares widely at the lambdoidal crest. The pits in the supraoccipital for the attachment of the semispinalis capitis muscle are shallow, as is characteristic of the Palaeotragine group of giraffids, as contrasted with the more advanced Sivatherines and Giraffines, in which these pits are quite deep.

In a consideration of the basicranium it may be well to take up the several elements separately, in order that they may be discussed according to their positions and functions. Therefore, the floor of the brain case will first be considered, after which there will be a discussion of the auditory apparatus, and then finally some attention will be paid to the articulations and the attachments for the jaw and for the masticating muscles.

The basicranium is rather wide in comparison to its length. The basioccipital is broad and is characterized by its large basilar tubercles, for the attachments of the rectus capitis ventralis major muscles. These tuberosities are much more prominent than in the modern okapi or giraffe; indeed, they are relatively larger than in *Samotherium* or *Palaeotragus*, and are quite comparable to the same structures in *Bramatherium*. The basisphenoid has low ridges along either edge.

In contradistinction to most of the Giraffidae, the posterior nasal choanae are situated somewhat behind the third molar, instead of being directly in line with the posterior border of the last tooth. The pterygoids of *Giraffokeryx* are developed much as they are in the okapi. Owing to the fact that this animal was fully adult, the sutures are largely

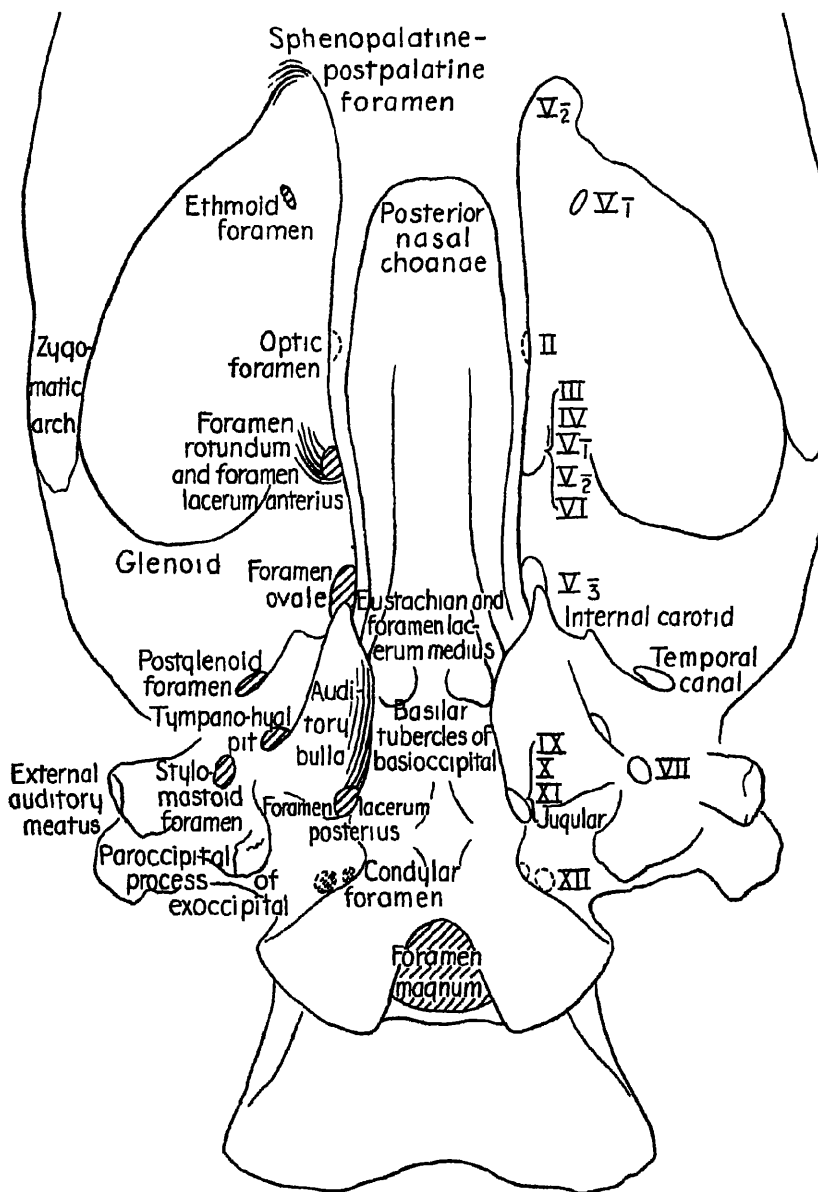


Fig. 4.—Diagram of basicranium and adjacent regions of the skull of *Gtraffokery. punjabiensis* Pilgrim. Names of foramina shown on left side of diagram; position of nerves and blood vessels on right.

obliterated, making precise determinations of the basicranial elements uncertain, but undoubtedly the alisphenoid ran well up within the orbit.

Coming now to the basicranial foramina, it may be seen that the ethmoid and optic foramina are large and separated from each other. As in the okapi there are two large foramina at the base of the alisphenoid, the anterior one of which would seem to be a fusion of the foramen rotundum and the foramen lacerum anterius, while the one posterior to it is undoubtedly the foramen ovale. Thus the anterior foramen served as a common passage for the oculomotor, the trochlear, the first and second branches of the trigeminus and the abducens nerves, while the posterior foramen transmitted the mandibular or third branch of the trigeminus. The development of the foramen lacerum medius is similar to that in the okapi, namely, it together with the opening for the Eustachian tube, is concealed above the anterior point of the bulla. The stylomastoid foramen is large, evidently carrying a well developed facialis nerve, and again, the postglenoid foramen is of unusually great size. In both of these characters, *Giraffokeryx* is similar to the okapi. The foramen lacerum posterius is of normal development, and separate from the foramen lacerum medius.

In *Okapia* there are two well developed condylar foramina for the branches of the hypoglossal nerve. It is difficult to be certain about this region in the skull of *Giraffokeryx*, because of the manner of preservation, but probably these foramina were well developed. The reader is referred to the accompanying figure of the basicranium of *Giraffokeryx*, in which the various foramina are labeled.

The auditory bulla is of medium size, though not as large nor as inflated as in *Okapia*. In *Giraffokeryx* the bony tube of the external auditory meatus points posteriorly, while in *Okapia* this structure is placed almost transversely.

Coming now to the articulation of the lower jaw, we see that the glenoids are convex as in the okapi. The pterygoids are fairly heavy, showing the power of the internal pterygoid muscles to move the jaw from side to side. The short heavy paroccipital processes would point to strong digastricus muscles.

The palate is wide and flat. The cheek teeth are well worn, again an indication that this was a fully adult animal at the time of its death. There are but three premolars, the first one having been lost during the course of evolutionary development. The muzzle is missing anterior to P², but undoubtedly there was no canine, and the premaxillaries were edentulous. The cheek teeth are brachyodont, showing this animal to be

primitive, even though aberrant, and they are marked by the characteristic giraffid rugose enamel. The second and third premolars are greater in length than in width, and each tooth is characterized by a strong anterior style, and an internal posterior swelling. In the last premolar the width considerably exceeds the length. The molars are approximately quadrate, with the protocone and metacone of about equal size, and with strong parastyles and mesostyles.

An isolated tooth (Amer. Mus. No. 19611) shows the character of the last premolar. In this tooth the median outer barrel is well developed and there is a swelling on the posterior border of the inner crescent, which when worn forms a small enamel lake within the dentine.

Amer. Mus. No. 19472, listed above, demonstrates the form of the molars much more clearly than do the teeth in the skull. In each molar, along the ectoloph, the parastyle and mesostyle are strongly developed; the anterior barrel is strong, but on the posterior part the ectoloph is flat. A similar condition holds in *Palaeotragus*, but it is to be noted that the styles and barrels in *Giraffokeryx* are divergent, while in *Palaeotragus* they are parallel, a fact that finds its explanation in the greater hypsodonty, and consequently the more advanced state of the teeth, in the latter genus. The anterior inner crescent of each molar in *Giraffokeryx* has a slight cingulum. Moreover, this crescent extends lingually further than does the posterior crescent, which gives the anterior half of the tooth a greater transverse measurement than the posterior moiety. There are no inner pillars on the molars as in *Palaeotragus*.

Pilgrim speaks of the absence of an enamel fold in the posterior crescent of the molar of *Giraffokeryx*. Such a fold is present to a greater or lesser extent in all of the American Museum specimens, and in some of them it forms an enamel loop within the dentine.

All in all, the upper teeth of *Giraffokeryx* are very similar to those of *Palaeotragus*, demonstrating (as has been pointed out above, in connection with certain cranial characters) the close relationship existing between these two genera.

THE MANDIBLE

Amer. Mus. No. 19587, listed above, contains a complete set of grinding teeth, which differ from the teeth of *Palaeotragus* and *Okapia* mainly by virtue of their relative narrowness. The second premolar is relatively simple, consisting of a median cone or point, from which a single ridge extends forward, and to the back of which there is a posterior ridge, dividing to form a Y. The third premolar is more advanced,

having the main cusp placed exteriorly. Anteriorly the ridge divides so as to form two prongs pointing lingually, while posteriorly there are three such prongs. There is a low internal wall to this tooth. In the fourth premolar the internal wall has developed to form a high internal ridge, rising to a point opposite the external cone. The external ridge divides into three prongs posteriorly, as in the preceding tooth. In P_3 and P_4 there are anterior external cingula.

The molars consist of the familiar artiodactyl crescents, and naturally in the third molar there is an additional posterior loop or talonid. Cingula are present anteriorly on the internal and external sides. The enamel is

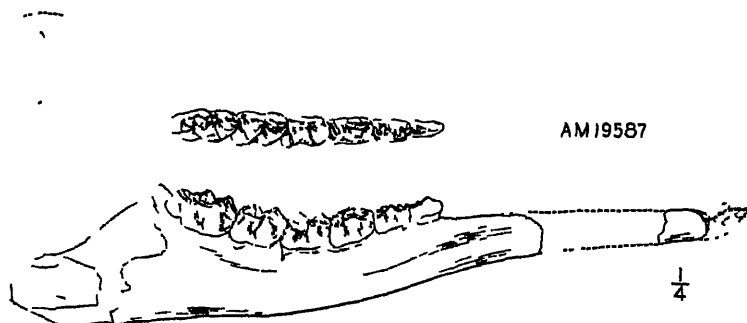


Fig 5.—*Giraffokeryx punjabiensis* Pilgrim Amer. Mus. No. 19587. Right ramus of mandible, lateral view. Crown view of grinding teeth, above. Restored portions indicated by dotted lines. The length of the restored premolar-canine diastema is based on comparisons with *Palaeotragus*. One-fourth natural size.

rugose. There is a strong external median pillar in the first molar, and rudimentary knobs in the succeeding teeth.

The incisor alveoli are present, but a portion of the ramus forming the diastema was lost. Undoubtedly this diastema was long, as in *Palaeotragus* or *Okapia*, and it would seem as if the ascending ramus was shaped much as in the latter genus.

MEASUREMENTS

SKULL.—Amer. Mus. No. 19475.

Length, P^2 to condyle	326 mm.
Estimated total length	500
Height above M^3 (to superior border of orbit)	85
Restored height	110
Antero-posterior diameter of orbit	66
Postorbital length (front of orbit to condyle)	222

MEASUREMENTS (Continued)

SKULL.—Amer. Mus. No. 19475 (Continued)

Estimated preorbital length	278
Width between tips of anterior horn cores	277
Width between tips of posterior horn cores	403
Width of confluent base of anterior horn cores	142
Distance between bases of posterior horn cores	123
Greatest width across squamosals	144
Width at narrowest portion of parietals	56
Width across zygomatic arches	179
Width of maxillae above P ²	80
Width of palate at M ³	66
Width of occipital condyles	76
Distance, anterior border of foramen magnum to border of posterior nasal choanae	150
Width between orbits	134
Width between tips of paroccipital processes	88

MANDIBLE.—Amer. Mus. No. 19587

Depth of ramus below third molar	43
----------------------------------	----

UPPER DENTITION.—

<i>Giraffokeryx pangabiensis</i> Amer. Mus. No. 19475		<i>Palaeotragus microdon</i> (After Bohlin) ¹	
	Antero-posterior	Transverse	Antero-posterior
	22 mm.	19 mm.	18 mm.
P ²	22 mm.	19 mm.	18 mm.
P ³	20 5	20	18
P ⁴	17 5	21	18
M ¹	22	24	23
M ²	25	27	26
M ³	24.5	26	25
			27

LOWER DENTITION.—

Amer. Mus. No. 19587		(After Bohlin) ²	
P ₂	18	9	10
P ₃	20 5	12	13
P ₄	24	15	15
M ₁	24	16	17
M ₂	25	27	23
M ₃	37	17	36
			18

Ratio, premolar to molar length

Upper dentition	83	73
Lower dentition	71	55 ³

¹Bohlin, B. 1927. 'Die Familie Giraffidae.' Pal. Sinica, Ser. C, IV, Fasc. 1, p. 27, column d in table.²Bohlin, B. 1927. *op. cit.*, p. 29, column I in table³Missing measurements obtained from other specimens listed by Bohlin.

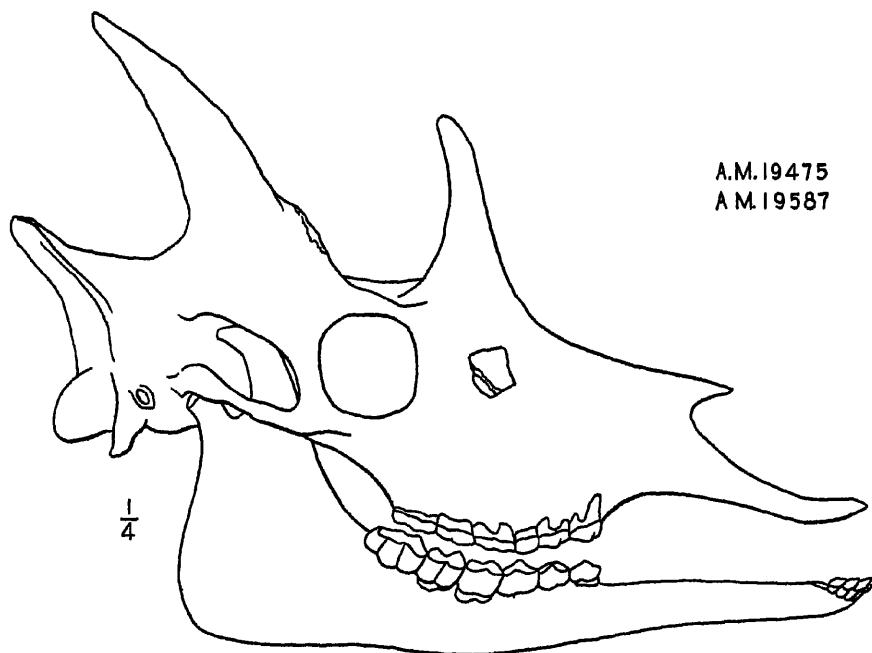


Fig. 6—Restoration of the skull and mandible of *Giraffokeryx punjabiensis* Pilgrim, showing the probable appearance of the skull with the crushing removed. One-fourth natural size.

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TWO NEW RODENTS FROM THE LOWER SIWALIK BEDS OF INDIA

By EDWIN H. COLBERT

The remains of rodents have been exceedingly rare among the fossils found in the Siwalik beds of northern India. Notwithstanding the fact that these sediments have been searched for more than a hundred years by various palaeontologists and stratigraphers, thereby yielding a tremendous quantity of fossil vertebrates, only ten specimens of rodents, representing four genera and five species, have thus far been recorded among the mammalian remains. These species and their occurrences are listed below.

<i>Rhizomys swalensis</i> Lydekker	Middle Siwaliks
<i>Rhizomys</i> sp. Lydekker	Upper Siwaliks
<i>Hystrix sivalensis</i> Lydekker	Middle Siwaliks
<i>Hystrix</i> cf. <i>leucurus</i> Sykes	Upper Siwaliks
<i>Nesokia</i> cf. <i>hardwickii</i> Gray	Upper Siwaliks
<i>Caprolagus sivalensis</i> Major	Upper Siwaliks

By this list it may be seen that all the rodent material so far discovered is from the middle and upper beds of the Siwalik series. Consequently the American Museum is fortunate in having obtained two new rodents from the lower Siwalik beds, thereby extending the geologic range of this order down into the upper Miocene or lower Pliocene in northern India. The specimens were found by Mr. Barnum Brown, during the course of his field work carried on in the northern Punjab for the Museum in 1922. They are described in the following pages.

The drawings in this paper were made by Margaret Matthew.

Family SPALACIDAE

Rhizomys punjabiensis, new species

TYPE -- Amer Mus No. 19762 The right ramus of a mandible, containing the second and third molars, and the posterior portion of the incisor.

HORIZON AND LOCALITY -- From the Lower Siwalik beds, near the base. The specimen was obtained at a point near the Sutlej River, about twenty-three miles west and north of Bilaspur, Bilaspur State, Punjab.

DIAGNOSIS. -- A small spalacid rodent, about one half as large as *Rhizomys sivalensis*, and about equal in size to *Rhizomys sinensis*. Dental formula 1-0-0-3, as in other members of the Spalacidae. Molar teeth characterized by an external and two or three internal folds.

This is a rather small species, being somewhat more than half as large as the Middle Siwalik form, *Rhizomys swalensis*. The lower border of the horizontal ramus is seemingly fairly straight, and above it on the outer side of the jaw, is the anterior portion of the masseteric crest. This crest has its anterior origin below the posterior border of the first molar.

The incisor, which is extremely long, is flat on the inner side, while the outer side is rounded, thereby giving the tooth a D-shaped cross section. The second molar is almost identical in its pattern to the corresponding tooth of *Rhizomys swalensis*,

as figured by Lydekker.¹ There is a deep external fold directed obliquely posteriorly, and three internal folds, which in the worn tooth persist as enamel fossettes. These fossettes are arranged with their long axes placed transversely, and the anterior one, the largest of the three, is expanded on its outer portion.

The third molar is similar to the preceding tooth, but the posterior part is somewhat constricted. The outer re-entrant fold is directed transversely, and has therefore crowded the two front fossettes, so that they have become confluent. Consequently there are only two inner fossettes in this tooth, a large one in front of the external fold, and a smaller one behind it.

The teeth are moderately hypodont.

AM 19762

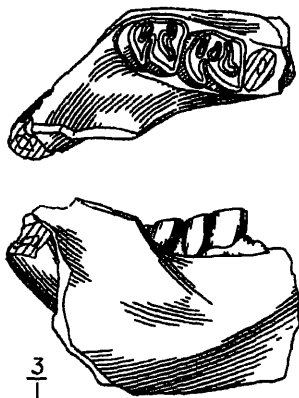


Fig. 1.—*Rhizomys punjabiensis*, new species. Amer. Mus No 19762.

Right mandibular ramus, with second and third molars. Crown view above, lateral view below. Three times natural size

MEASUREMENTS

Rhizomys punjabiensis, new species

Amer. Mus. No 19762.

Length of RM_2	2.7 mm
Width of RM_2	2.4
Length of RM_3	3.1
Width of RM_3	2.6
Length of M_2-M_3	5.8
Depth of ramus below M_2	6.0

¹Lydekker, R. 1884. 'Rodents and New Ruminants from the Siwaliks and Synopsis of Mammalia' Mem. Geol. Surv. India, Pal. Indica, (X) III, Pt. 3, pp. 106-108, figs. 1, 2.

***Rhizomys sivalensis* Lydekker**[After Lydekker, 1884—*op. cit.*, p. 107]

Length of three molars	74 in	18 7 mm.
Width of M_3	25	6.3
Vertical diameter of incisor	17	4 3

***Rhizomys sinensis* Gray**[Measured from a plate, published by Forsyth Major²]

Length of upper molar series	11 5 mm
Length of M^2-M^3	7 5
Depth of ramus below M_3	13 5

***Rhizomys troglodytes* Matthew and Granger**

Amer. Mus. No. 18411

Length of RM_2	4 8 mm.
Length of RM_3	4 3
Length, M_2-M_3	9 5
Length, M_1-M_3	14 5
Depth of ramus below M_3	14 0

Family HYSTRICIDAE***Sivacanthion complicatus*, new genus and species**

TYPE.—Amer. Mus. No. 19626. Two fragments of the mandible; a right ramus with P_4 (unerupted), and M_{1-2} ; a left ramus with P_4 , M_{1-2} , and the alveolus of M_3 . The left premolar has been uncovered, to show its coronal pattern.

HORIZON AND LOCALITY.—From the Lower Siwaliks at the level of Chunji Rest House. Four miles northeast of Chunji Rest House, Salt Range, northern Punjab.

DIAGNOSIS.—An hystricomorph of medium size, considerably smaller than the modern species of *Hystrix* or *Acanthion*. Dental formula 1-0-1-3. Angle of mandibular ramus very strong, as in other Hystricidae. Hystricomorph pattern of the molar enamel complicated by secondary foldings.

The jaw under consideration represents an animal intermediate in size between *Hystrix* or *Acanthion*, and *Atherura*, though somewhat nearer to the latter. The portions preserved show typical hystricomorph characters, in that the ramus is rather deep, and its lower border is curved, while the angular portion is rather distinct from the ramus. The masseteric crest has its beginning beneath the midportion of the first molar, as in *Hystrix*, and the ascending ramus arises opposite the second molar. The bone enclosing the incisor forms a prominent ridge on the inner, and along the lower border of the ramus, as in *Acanthion*.

The cheek teeth, while they are of typically hystricomorph pattern, are very complicated because of the development of numerous accessory

²Major, C. J. Forsyth. 1897. 'On the Malagasy Rodent Genus *Brachyuromys*; and on the Mutual Relations of some Groups of the *Muridae* (*Hesperomysinae*, *Microtus*, *Murinae*, and "*Spalacidae*") with each other and with the Malagasy *Nesomys*' Proc. Zool. Soc. London, Pl. xxxviii.

tubercles. Thus the enamel pattern of the worn molar is complex, even though it is fundamentally the same as in *Hystrix* or *Acanthion*. Reducing the tooth pattern to its simplest terms, it is seen to consist of a single external reentrant fold, directed obliquely posteriorly, and of three internal folds, the anterior one of which is the largest and most complex. For the details of the molar pattern, the reader should refer to the accompanying figure

Undoubtedly the complex enamel folding in this species represents an early and a rather aberrant specialization of the molar pattern. Yet

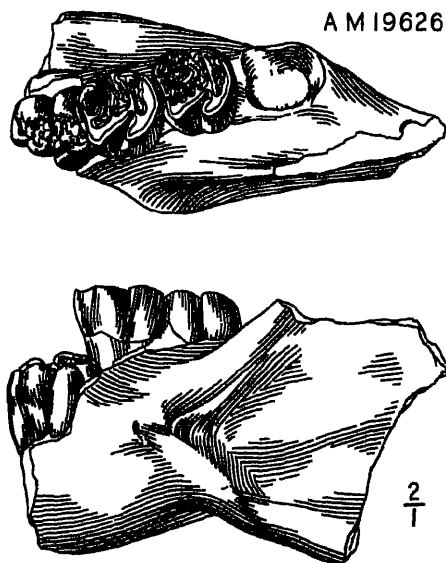


Fig. 2.—*Swacanthion complicatus*, new genus and species. Amer. Mus. No. 19626.

Left mandibular ramus, with fourth premolar, and first and second molars. The alveolus for the third molar is shown behind the second molar. Crown view above, lateral view below. Twice natural size.

in contradistinction to the specialized crown pattern of this Siwalik form, the tooth itself remains fairly primitive by virtue of its relative brachyodonty. Therefore we must regard this genus as an aberrantly specialized side branch in hystricomorph evolution, a form that developed a complicated enamel pattern, but that never progressed very far towards hypsodonty in the molars.

The genus under discussion is seemingly most nearly related to *Hystrix* or *Acanthion*, to which genera it bears a close resemblance in the

shape of the mandible. Moreover, the tooth pattern is fundamentally similar to that in *Acanthion*. As to size and brachyodonty of the molars, the fossil genus shows certain resemblances to the recent *Atherura*.

MEASUREMENTS

Sivacanthion complicatus, new genus and species

Amer. Mus. No. 19626.

P ₄	Length	6 1 mm.
	Width	5 7
	Height	6 3
M ₁	Length	5 3
	Width	5 1
M ₂	Length	5 2
	Width	5 4
	Length of molar series (M ₃ from alveolus)	16.8
	Depth of ramus below M ₁	13 8

Acanthion suboristatus papae Allen

Amer. Mus. No. 60142.

P ₄	Length	8 0 mm.
	Width	6.5
M ₁	Length	8 0
	Width	7 0
M ₂	Length	7 8
	Width	6 7
M ₃	Length	6 0
	Width	5 0
	Length of molar series	22 5
	Depth of ramus below M ₁	20 5

Atherura macroura hainana Allen

Amer. Mus. No. 60146.

P ₄	Length	4 5 mm.
	Width	3 5
M ₁	Length	4 5
	Width	3 9
M ₂	Length	4 5
	Width	—
	Depth of ramus	8 3

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58 07

A SIMPLIFIED SERIAL SECTIONING TECHNIQUE FOR THE STUDY OF FOSSILS

BY GEORGE GAYLORD SIMPSON

Thin sections are extensively used in the study of fossils. They are part of the standard technique for the study of some invertebrates (e.g., fusulinids) and plants (silicified wood, coal balls, etc.) and they are occasionally employed in vertebrate paleontology (e.g., the work by Carter on enamel histology and that by Moodie on pathologic tissues and ossified tendons). Serial thin sections, as employed so extensively in recent biology, would be of still greater value. If, however, such series were to be made with paleontological materials, the space lost between each section would be many times greater than the thickness of the sections themselves, and the successful preparation of many successive thin sections would be extremely arduous, require a high degree of skill and elaborate equipment, and involve at best some failures and many imperfect sections. Serial thin sections are very seldom practical in paleontological research.

To overcome these difficulties, W. J. Sollas¹ devised a technique for the preparation of serial opaque sections by grinding a specimen down to successive parallel planes. The specimen itself is destroyed, but its morphology is determined and permanently recorded by drawings or photographs and by models. This method adds immeasurably to the technical resources of paleontological research, and it has been employed with brilliant results by Sollas and by a few others, notably Stensio.²

This technique is so promising and its results so remarkable that it is surprising to see how little use has been made of it. This relative neglect is apparently due mainly to two factors. In the first place, the most puzzling specimens and those most imperatively needing such a method for their elucidation are usually rare or even unique, so that any mode of study that destroys the original is unwarranted. This is an inherent

¹Sollas, W. J. 1903. 'A method for the investigation of fossils by serial sections.' *Phil. Trans. Roy. Soc. London*, (B) CLXXXVI, pp. 259-285.

²Sollas, W. J., and W. J. Sollas. 1913. 'A study of the skull of *Dicynodon* by means of serial sections.' *Phil. Trans. Roy. Soc. London*, (B) CCIV, pp. 201-225.

³For example:

Stensio, R. A. 1927. 'The Devonian and Devonian vertebrates of Spitzbergen.' Part I. Family Cephalaspidae. *Skrifter om Svalbard og Nordshetland, Norske Vidensk.-Akad. Oslo*, No. 12. 1932. 'Triassic fishes from East Greenland.' *Meddelelser om Grønland, Kom. Vidensk. Unders. Grønland*, LXXIII, No. 3.

disadvantage which sharply limits the use of serial sections, but it still leaves a large field of usefulness. Every collection does contain specimens that could be more usefully employed in this way than in any other. Furthermore, many symmetrical specimens, even though rare, could legitimately be divided into halves, one side to be used for sectioning and the other for surface morphology and permanent record. The second difficulty, which has probably been the more important reason for the neglect of this method, is that the preparation of adequate sections has usually demanded either remarkable skill and hard labor or else very expensive and complex apparatus.

The simple procedure here suggested seems in large measure to do away with the difficulty and expense of the serial sectioning of fossils. The results are valuable out of all proportion to the cost, in time or money, and it is hoped that a wide use of serial sections may result. The necessary apparatus need not cost more than a dollar or two and the procedure is very rapid and requires no special skill or training. The machines illustrated by Sollas probably gave slightly more exact results, but in practice the present method proves to be entirely adequate for any reasonable purpose. More elaborate equipment or procedures could hardly produce a useful improvement in results.

This method involves no particular originality, and its publication is prompted only by the desire to share a useful tool with others. I am indebted to C. S. Williams for the actual construction of the apparatus and for some suggestions regarding its design and use. The method has been used in the study of parts of small mammal skulls. Serial sectioning does not appear to have been employed previously in the study of fossil mammals, but the results, which will be published elsewhere, are excellent and could have been obtained in no other way. Any paleontological specimens or parts of specimens could be used up to a diameter of perhaps 60 mm. Larger specimens would require an apparatus similar to that of Professor Sollas, or would have first to be cut into smaller segments.

The requirements of successful serial sectioning are the means to:

1. Grind smooth, plane surfaces without chipping.
2. Orient these surfaces with respect to some selected axis.
3. Keep successive sections parallel to each other.
4. Maintain a known and uniform distance between sections.
5. Preserve the unground part of the specimen undamaged until used.

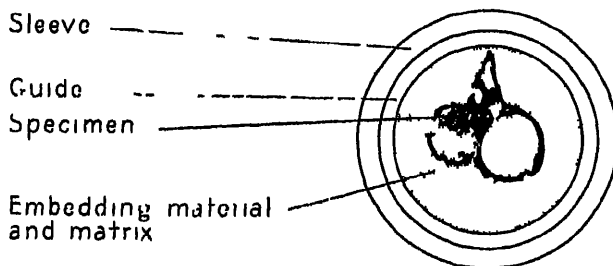
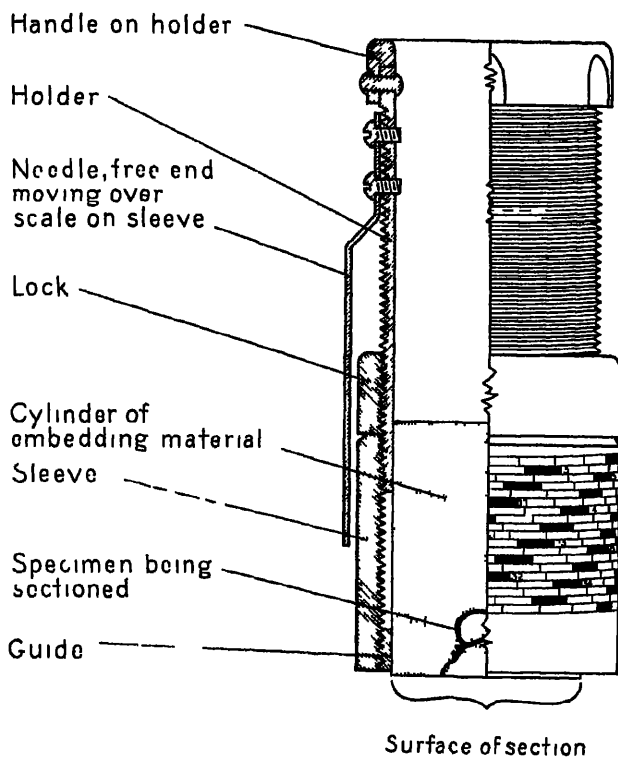


Fig 1 - Simplified serial sectioning apparatus The left half is shown in vertical median section and the right in external view Below is shown the working face, with a cut section in position In the side view, the specimen is shown protruding slightly beyond the end of sleeve and guide, ready to cut the next section

The simplest possible procedure, holding the specimen by hand and grinding against a lap or stone, obviously cannot meet any of these conditions to the required degree and some sort of specimen holder is therefore a primary need. In the method here described, the holder, proper, is a piece of ordinary metal pipe with inside diameter several millimeters larger than the maximum dimension of the sections to be ground and the outer surface threaded for most or all of its length. In addition there is required a metal sleeve, shorter than the holder and longer than the total thickness to be covered by any one series of sections, with internal threads fitting the external threads of the holder. The sleeve should be fairly thick and of hard metal, and one end should be ground or machined to a plane surface at right angles to the axis of the cylinder.

These two pieces are all that is absolutely necessary, but several additions increase the ease of use and accuracy of results and are easily constructed. As a guide, a very short section of the same sort of threaded pipe as the holder may be permanently fixed at the machined end of the sleeve, so that its outer end is flush with and forms part of that plane surface. Some sort of grip or handle at one end of the holder will make it easier to screw this into the sleeve. A shorter, separate sleeve segment screwed onto the holder between its grip and the main sleeve forms a convenient means of locking sleeve and holder together at any desired point. Finally a pointer fixed to the holder and passing over a properly calibrated scale on the sleeve will make it easy to measure the distances between sections. The scale may be calculated from the known pitch of the threads and the outside circumference of the sleeve and then drawn on paper and shellacked to the sleeve.

For grinding, a lap may be used by simply bringing the holder to bear against its plane surface by hand. If a lap is not available—and this may be found as quick and easy in any case—two or three ordinary, flat, rectangular sharpening stones of different degrees of fineness will serve just as well. It will be found easiest to hold the specimen in its carrier stationary and upright and to move the stone across it. Both stones and section should be kept wet and washed as needed. The stones may be kept plane, if necessary, by rubbing them against each other occasionally. As the amount removed at each cut is small, hand grinding is easy and rapid, averaging five minutes or less for each section.

In using the apparatus, the specimen to be ground is embedded, with the desired orientation, in one end of a cylindrical block of suitable material. In practice, plaster mixed so as to set with fine grain and few

bubbles, dried, and then impregnated with thin shellac has been found excellent for embedding. The cylinder should be cast in the specimen holder, well greased to facilitate removal.¹ The specimen is embedded in one end of the cylindrical plaster block, and the other end should project far enough for firm attachment in the holder, as detailed below.

After removal from the mold and any further preparation (such as thorough shellacking), that end of the block not containing the specimen is inserted into the holder far enough to be held firmly, but leaving the part with the specimen freely projecting. It is fixed in this position. The holder and the embedding cylinder now projecting from it are then screwed into the sleeve far enough to bring the specimen to the far end of the latter, the end machined to a plane surface. The exact amount to be removed at the first cutting is then exposed by screwing the holder farther into the sleeve. After the first grinding, the holder is again screwed in for a determined distance and the operation repeated. Each section is ground flush with the machined end of the sleeve and guide.

The planes so ground are exactly parallel because each is determined by the machined end of the sleeve, which is exactly transverse to the axis along which the specimen is moved between cuts. The end of the sleeve and guide is so much harder than the embedded specimen that it is easy to stop grinding when it is reached. It wears slowly, but in a given case of a series of over fifty sections the total wear was less than 0.1 mm., or less than .002 mm. per section, which is completely negligible. The interval between sections is easily measured or predetermined by the amount to which the holder is screwed into the sleeve, and by making this the same each time, the sections are kept exactly equidistant from each other.

Care should be taken to keep the threads well oiled and to prevent the embedding cylinder from adhering to the guide, if one is used.

Primary records taken are a drawing or a photograph of each section. Whether drawings or photographs are preferable will depend on the nature of the specimen and on personal judgment. If photographs are used, each should be developed, printed, and retouched before the next section is ground. The specimen is left in the apparatus for drawing or photographing, and the apparatus itself is a convenient holder and means

¹Embedding in this way is the procedure advocated in Koslowski, R. 1932 'Sur un procédé simple et précis d'effectuer coupes sérielles des fossiles.' *Pal. Zeits.*, XIV, pp 316-318

Koslowski then recommends holding the embedding cylinder by hand during the grinding. As he points out, however, this gives no assurance of equal thickness between successive cuts. It may also be noted that it does not, in fact, keep the cuts parallel and that these two disadvantages make the method too inaccurate for most purposes. His method may be useful when little accuracy is required, but in general the present procedure is hardly more difficult and certainly gives much better results.

of orientation for this purpose. For additional orientation, two small holes bored in the embedding medium (but not through the specimen) may be helpful.

If desired, wax models or copies on sheets of glass (both suggested and described by Sollas) may be prepared from the drawings or photographs for further study.

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AN UPPER TERTIARY PECCARY FROM INDIA

By EDWIN H. COLBERT

INTRODUCTION

The distribution of fossil and recent bunodont artiodactyls has shown that the Suidae, or the true pigs, have always been limited to the Old World, while the Tayassuidae, or peccaries, have been and are characteristic of the New World, and so clear-cut have been the restrictions of these two families to the two hemispheres that palaeontologists and zoologists have come to look upon their geographic separation as almost an ironbound law. In fact, Dr. W. D. Matthew, in his brilliant essay "Climate and Evolution," indicated separate centers of origin for the pigs and the peccaries.¹ The former, according to Doctor Matthew, had their origin in Central Asia, while the latter began their phylogenetic development in the western portion of North America.

Recently, however, Miss Helga S. Pearson, following the lead of Hans G. Stehlin, suggested that peccaries actually were present in Europe during the Oligocene period.² She based her conclusions on the characters of the genus *Dolichochoerus*, which form she considers to be of tayassuid rather than of suid affinities.

Certain specimens discovered by Mr. Barnum Brown, in the Punjab of northern India, during the course of his explorations in the season of 1922 for the American Museum, would seem to confirm Miss Pearson's conclusions as to the presence of Tertiary peccaries in the Eastern Hemisphere. These specimens, which will be described in this paper, consist of several teeth that would seem to represent a strange but nevertheless a true peccary. The teeth, when first found, proved to be very baffling, and it was only after careful comparisons with numerous specimens from different mammalian orders, as well as long considerations of all the probable taxonomic possibilities, that the specimens were finally assigned to the Tayassuidae. During the course of this study the author

¹Matthew, W. D. 1915. 'Climate and Evolution' Ann. New York Acad. Sci., XXIV, p 241, fig. 21

²Pearson, H. S. 1927 'On the Skulls of Early Tertiary Suidae, together with an Account of the Otis Region in some of the Primitive Artiodactyla.' Phil. Trans. Roy. Soc. London. Series B, Vol. 215, pp. 400-403, 400-410, 458.

had the constant and interested aid of Dr. W. K. Gregory, and by means of this help a better understanding of the fossils under consideration was obtained.

The drawings and charts illustrating this paper were made by Margaret Matthew.

DESCRIPTION

Pecarichoserus orientalis, new genus and species

TYPE.—Amer. Mus. No. 29955. Various isolated upper cheek teeth; particularly an RP⁴ (?), LM¹, R and LM³.

HORIZON AND LOCALITY.—From the Chinji zone, Lower Siwaliks, at a point 1600 feet above the level of Chinji Rest House. The specimens were found three miles west of Chinji Rest House, in the Salt Range, Northern Punjab.

DIAGNOSIS.—Molar teeth short, brachyodont and quadricuspid. Cusps conical and separated from each other. Median valley of the third molar occupied by sharp, oblique ridges, which run between the anterior and the posterior pairs of cusps. Enamel smooth.

The isolated fragments which go to make up this new type have been identified as follows:

1. The alveolus of an upper premolar tooth.
2. The roots of an upper premolar tooth.
3. A right and a left upper premolar tooth.
4. A right and a left upper first molar.
5. A right and a left upper third molar.

Obviously the first two items listed above are of little value for the purpose of identification or study. As to the two premolar teeth, they have been subjected to rather hard usage, with the result that they are worn and broken to an extent that makes their determination difficult. The two first molars, though fairly complete, were subjected to a great deal of occlusal wear during the life of the animal, so that the coronal patterns were entirely obliterated. Consequently we must rely on these teeth mainly for the purpose of general shape and proportions. The two third molars are complete and only slightly worn, thereby furnishing us the only reliable information as to the probable affinities of this animal.

The first molar is a tooth of rectangular shape, being somewhat longer than it is wide. Evidently in the unworn condition the tooth was quadricuspid, the cusps being somewhat oblique to the midline of the tooth.

The last molar is quadricuspid, there being evidently the protocone, paracone, metacone and metaconule represented. These four cusps are round and quite separate from each other. There is a distinct and a rather broad anterior cingulum, and back of this a short ridge or bar runs

transversely across the front of the tooth, connecting the anterior edges of the protocone and the paracone. From the outer or buccal side of the protocone a ridge runs back and out towards the metacone, being joined in the median transverse valley by a similar bar or ridge running forward from the outer edge of the metaconule. Together these ridges form a broad V, with the apex directed buccally. From the back of the pos-

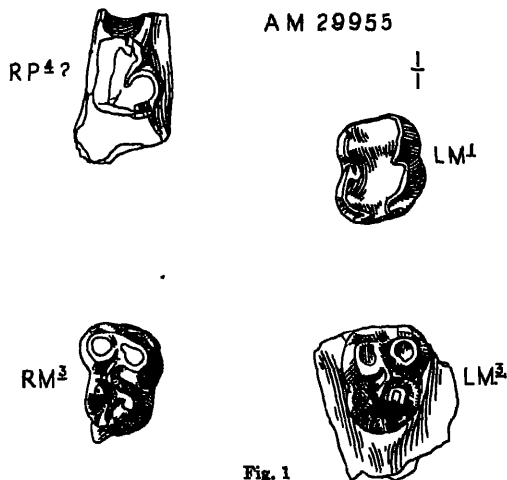


Fig. 1

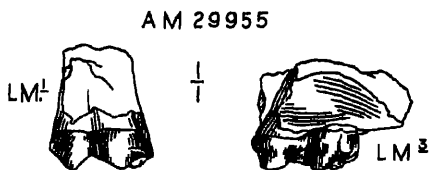


Fig. 2

Fig. 1. *Pecarichoerus orientalis*, new genus and species. Amer. Mus. No. 29955. Isolated upper cheek teeth, placed in the approximate positions they would occupy in the palate. Crown views, natural size.

Fig. 2. *Pecarichoerus orientalis*, new genus and species. Amer. Mus. No. 29955. Left upper first and third molars, placed in the approximate positions they would occupy in the palate. Side views, natural size.

terior ridge a small accessory ridge runs backwardly between the metacone and the metaconule, and having reached a point slightly behind the posterior border of the metaconule it doubles forward to join on to the postero-internal surface of that cusp. There is a posterior cingulum. The enamel is very smooth.

DISCUSSION

The presence of the peculiar oblique ridges in the molar described above, at once suggested that these teeth might represent a primate related to *Oreopithecus*, a characteristic Pliocene genus of Europe. A comparison shows, however, that the third molar is not only much longer in proportion to its width than is the case in *Oreopithecus*, but also that the ridges are arranged quite differently in the two genera, as is shown by the accompanying diagram (figure 3). Thus the resemblances to *Oreopithecus* are seen to be fortuitous, rather than real, and we must needs look elsewhere for homologous comparisons.

Turning now to the Suidae, we find that the two genera offering the closest comparisons to the specimens under consideration are *Palaeochoerus* and *Hyotherium*. We might expect these genera to be similar to the genus now in question, especially as they are of contemporaneous or of earlier ages. In *Palaeochoerus*, however, the third molar is seen to have a

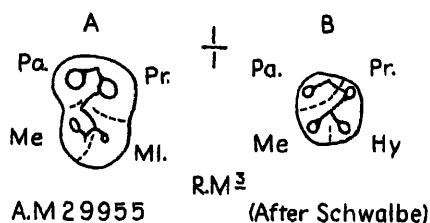


Fig. 3. Diagram to show the relationships of cusps and ridges in the right upper third molars of (A) *Pecarichoerus orientalis*, and (B) *Oreopithecus bambolii*. Crown views, natural size.

quite different shape from the corresponding tooth in *Pecarichoerus*, for in the suid the tooth is transversely broad at the anterior end, narrowing from there back to a pointed talon, while in the supposed peccary the posterior end of the tooth is more nearly equal to the anterior end in its transverse measurement, and in addition there is no talon, but only a rounded cingulum. Moreover, in *Palaeochoerus* there are numerous wrinklins in the enamel, while in *Pecarichoerus* the enamel is very smooth. Then again, in *Palaeochoerus* the cusps are not as separate nor as round as in the Indian peccary. Finally, there are no semblances of oblique ridges in *Palaeochoerus*, but rather the median valley of the molar is occupied by a small tubercle.

The same differences that set *Palaeochoerus* apart from *Pecarichoerus* also serve to distinguish *Hyotherium* and *Conohyus* from it, except that

in these latter genera the enamel tends to be rather smooth. Perhaps this brief résumé will show that there are no striking resemblances to be found between *Pecarichoerus* and any of the Suidæ most nearly like it

There now remain the peccaries to be considered. In North America *Perchoerus* (*Thinohyus*) is the characteristic Oligocene genus of this family, while *Prosthennops* is the form most common to the upper Miocene and the Pliocene. Taking these two genera together, it is seen that they demonstrate practically all of the characters that distinguish the seemingly peculiar Siwalik teeth described above. Thus, in the third upper molar of *Perchoerus* and *Prosthennops*:

1. The tooth does not taper to the back, nor is there a distinct talon. The posterior end of the molar is characterized by its rounded cingulum. (In shape the *Prosthennops* molar most closely resembles that of *Pecarichoerus*.)

2. The enamel is smooth.

3. The cusps are separate from each other.

4. In *Perchoerus* there is an intermediate protoconule and a metaconule, with broad and distinct oblique ridges running forward and back from the former, and forward from the latter. The ridges from each of these cusps meet in the median valley, to form an outwardly directed V. One need only imagine an accentuation of the oblique ridges of *Perchoerus*, accompanied by certain proportional changes in the molar, to arrive at the condition typical of *Pecarichoerus*.

Continuing, we may turn to a comparison of *Pecarichoerus* with *Dolichochoerus*, a genus found in the Phosphorites du Quercy (Oligocene) of France. Miss Pearson has shown that *Dolichochoerus* is a peccary, basing her conclusions on the following osteological characters.

1. The glenoid surface is lower than the basicranium.

2. The postglenoid process projects considerably below the posttympanic process.

3. The tympanic "neck" is concealed by a meeting below it of the postglenoid and the posttympanic.

4. A broad groove projects up from the glenoid on the postero-external side of the zygoma.

5. The pterygoids are rather small.

6. The paroccipital process is seemingly rather short and wide, and is posterior to the glenoid.¹

It might be well to add that the molar teeth of *Dolichochoerus*, by virtue of their simple quadritubercular form and their relative shortness, would seem to be more like the molars of a peccary than of a true suid.

¹Pearson, H. S. 1927. *Op cit.*, pp. 400-402.

Therefore, on the basis of all the evidence presented above, it seems pretty safe to conclude that *Dolichochoerus* is a peccary, closely related to *Perchoerus*.¹

Now when we compare the molars of *Pecarichoerus* with those of *Dolichochoerus*, we see that a great resemblance exists between the two genera. Both show the comparatively short, quadritubercular molars, having the cusps arranged somewhat obliquely to the midline of the

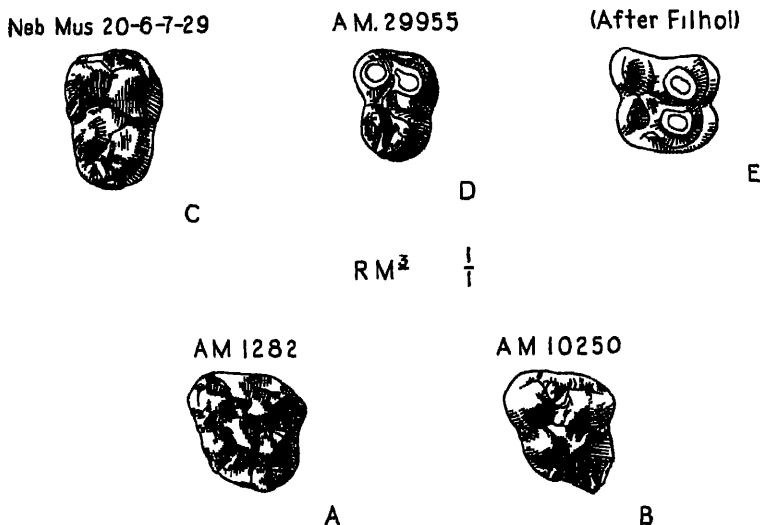


Fig. 4. Comparison of the right upper third molars in various fossil pigs and peccaries. Natural size.

A. *Perchoerus probus* Ledy Amer. Mus. No. 1282 Protocerat beds, Brulé formation, upper Oligocene, Chyenne River, South Dakota.

B. *Palaenchoerus masseneri* v. Mayer. Amer. Mus. No. 10250 Lower Miocene, Fekington bei Ulm, Germany.

C. *Prosthenhops* sp. Nebraska State Mus. No. 20-6-7-20. Lower Pliocene, near Ainsworth, Nebraska.

D. *Pecarichoerus orientalis*, new genus and species Amer. Mus. No. 29955 Chinji Beds, Lower Pliocene. Near Chinji Rest House, Northern Punjab, India.

E. *Dolichochoerus quercus* (Filhol) [Copied from a plate by Filhol.] Phosphorites du Quercy, Oligocene, France

tooth. Both genera are characterized by smooth enamel. In both, the cusps are separate from each other. True enough, *Dolichochoerus* does not show as great a development of the intermediate ridges as does *Pecarichoerus*, but this is a difference of degree rather than of kind. Consequently, on the basis of the above evidence, it would seem that *Pecarichoerus* is a true but specialized peccary, related to *Perchoerus* and *Prosthenhops* of North America, and more closely to *Dolichochoerus* of Europe.

¹Pearson, H. S. 1927 *Op cit*, p. 458.

TABLE OF MEASUREMENTS

Pecarichoerus orientalis, new genus and species. Amer. Mus. No. 29955.

M ¹	Length 13.5 mm.	Width 12.5 mm.	Index 93
M ³	Length 14	Width 12	Index 86

Prosthennops sp. Neb. Mus. No. 20-6-7-29.

M ³	Length 18 mm.	Width 13.3 mm.	Index 74
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Perchoerus probus Ledy. Amer. Mus. No. 1282.

M ³	Length 15.5 mm	Width 14 mm.	Index 90
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Palaeochoerus meisenneri v. Meyer. Amer. Mus. No. 10250.

M ³	Length 16 mm.	Width 14.6 mm.	Index 91
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CONCLUSIONS

There now comes the question of the derivation of *Pecarichoerus* and the implications raised by its presence in India. The older theory as to the separate origin of the pigs and peccaries (mentioned above) has been more or less disproven by the recent work of Miss Pearson. She has clearly demonstrated that the American genus, *Perchoerus*, and the European form, *Palaeochoerus*, are indeed closely related, and that they have descended from a not very distant common ancestor. According to Miss Pearson, *Palaeochoerus* is the European derivative of this common ancestral stock, and it gave rise to the true pigs, while *Perchoerus* is the American derivative which gave rise to the peccaries.

At the same time, *Doliochoerus* is an European cousin of *Perchoerus*, and must be regarded as a persistent remnant staying on near the center of origin of the group. *Pecarichoerus* now takes a position similar to that of *Doliochoerus*, in that it represents a persistent remnant near the center of origin for the peccaries.

We may imagine an Eurasiatic origin for the common ancestor of the pigs and the peccaries. Early in the history of the Tayassuidae, the group migrated to the Western Hemisphere (possibly by way of a trans-Bering land bridge), while a few hardy forms lingered on for a short time in the Old World. These holdovers we see in the genera *Doliochoerus* and *Pecarichoerus*, in Europe and in Asia respectively.

Recent evidence is accumulating to show that various Indian and Asiatic genera crossed to California in Tertiary times, and it would seem likely that the peccaries followed this general movement.¹

¹See papers by Merriam, Stock, Moody, Hall and Frick, cited in the bibliography.

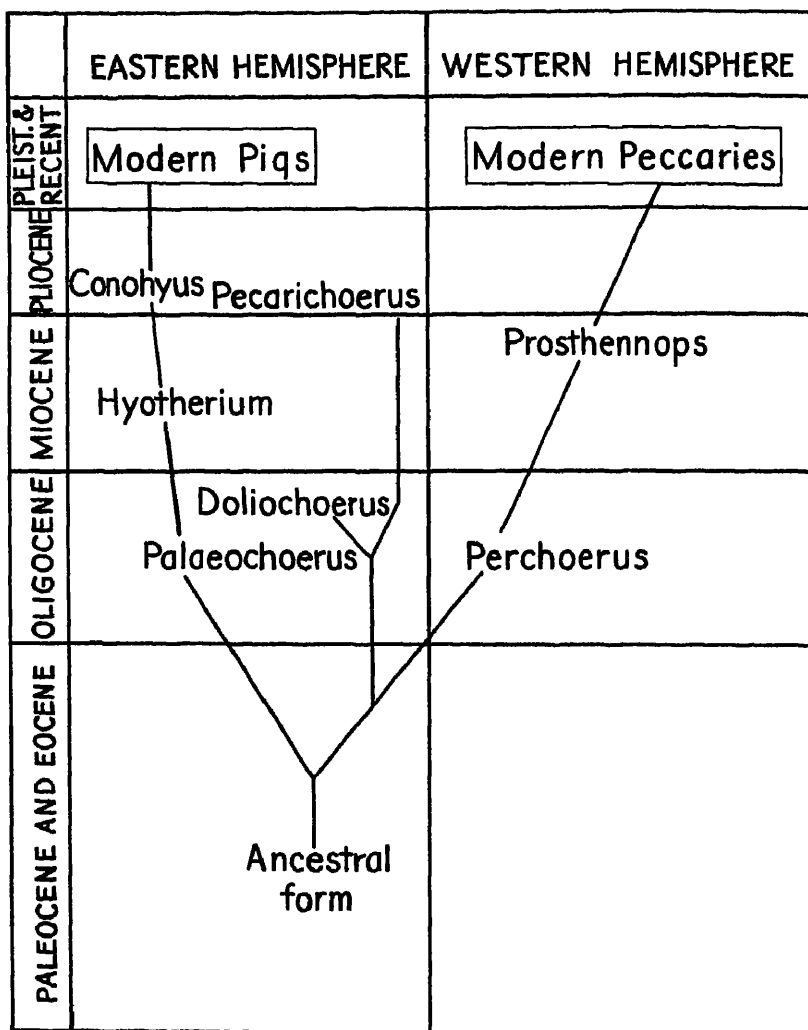


Fig. 5. Diagram, to show in an abbreviated form, the geologic and geographic relations of the pigs and peccaries.

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NEW GENERA AND SPECIES OF NORTH AMERICAN SPIDERS

By W. J. GERTSCH

In the following pages three new genera and a number of species of American spiders are described and figured, all pertaining to two families, the Thomisidae and Lycosidae. Of especial interest is the new genus *Tibellomimus*, which, though paralleling to a degree *Tibellus* in its elongate carapace and abdomen and in the characteristic dorsal longitudinal stripes, is more closely related to *Phlodromus* than to any of the other genera from the United States. Two other philodromid genera from the southwest are described, *Horodromoides* and *Titanebo*, the latter heretofore included in *Ebo*.

With the exception of four of the new species described below, the types are in the collection of The American Museum of Natural History.

Thanatus coloradensis Keyserling

Figure 5

Thanatus coloradensis KEYSERLING, 1880, 'Die Spinnen Amerikas,' Laterigradae, p. 206, Pl. v, fig. 113.

MALE.—Cephalothorax clothed with a thin coat of dark hairs closely appressed to the surface, with only a few short spines on the clypeal margin. Carapace a rich reddish-brown, medially with a rather faintly marked, broad, longitudinal, lighter band, scarcely evident at the eye region but more sharply defined caudally and ending before attaining the margin. Sides of the carapace dark brown. Eyes, appearing white by reflected light, on small black tubercles that are well separated. Sternum, coxae, labium, and maxillae light brown, often tinged with bright red. Femora of legs concolorous with the margins of the carapace, the distal joints light reddish-brown, all the members with a sparse coating of gray hairs. The metatarsi and tarsi thickly scopulate beneath. Palpal joints brown, somewhat streaked with black.

Abdomen furnished with a thick coat of flattened hairs, brown or black in color, the chromatism agreeing with the pattern, also with a number of spines distributed at intervals over the surface. Dorsum with a median dark longitudinal maculation that is rather narrow at the base of the abdomen but gradually expands at its mid point to practically the width of the anterior eye row, then again narrows to its end point just caudad of the middle of the dorsum. Sides of the dorsum brownish, flecked and marked with yellow. Venter light brown, with a darker streak on each side.

Total length, 5.80 mm.

Carapace, 2.70 mm. long, 2.46 mm. wide, 1.00 mm. in front. Abdomen, 3.23 mm. long, 1.77 mm. wide.

Carapace convex, moderately high throughout, the highest point being on a line between the third and fourth coxae, the cephalic sutures poorly indicated, the sides flatly sloping to the margins. Carapace suborbicular, a little longer than broad, truncate behind, the sides evenly rounded, anteriorly constricted at the second row of eyes and broadly truncate in front.

Eyes in two strongly recurved rows, the first row much broader (27/17) than the second. Anterior median eyes smaller and less than a diameter from the laterals, about one and one-half diameters from each other (2.5/4). Posterior median eyes slightly nearer to each other (6/7.5) than to the laterals which are somewhat larger. Median ocular quadrangle very slightly longer than broad (12/11), narrower in front, the eyes about equal. Anterior median eye over three times as far from the posterior median as the anterior lateral eye. Clypeus slightly sloping, as high as the median ocular quadrangle.

Legs rather slender, strongly spined, the first and third femora about equal to the length of the carapace. Spines under the tibiae 2-2-2. Leg formula 4213.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.74	1.16	2.27	1.96	1.50	9.63 mm.
II	3.20	1.23	2.56	2.13	1.60	10.72 mm.
III	2.80	1.06	2.33	2.00	1.43	9.62 mm.
IV	3.13	1.16	2.76	2.63	1.66	11.34 mm.
Palp	.90	.33	.33		1.16	2.72 mm.

Width of patella I, 0.43 mm. Tibial Index, 12.2.

Width of patella IV, 0.37 mm. Tibial Index, 9.4.

MALE PALPUS.—Femur longer than the tarsus or both the patella and tibia taken together. Tibial apophysis a strong short spur directed obliquely from the base of the tibia, eight-elevenths as long as the tibia from the ventral aspect, only three-elevenths as long as that joint when seen from the lateral view. Bulb much expanded, exceeding the cymbial margin on the retrolateral side, the distal embolic portion a fine spur a little longer than the tibia, curved ventrally and to the outer side. Conductor a short, colorless appendage beneath the tip of the embolus.

FEMALE.—Agreeing in detail with the male in pattern, but, as usual, a little lighter in color. Legs with two poorly defined streaks on the upper surface.

Total length, 7.50 mm. Carapace, 3.33 mm. long, 2.93 mm. wide, 1.40 mm. in front. Abdomen, 4.70 mm. long, 2.60 mm. wide.

Eyes in two strongly recurved rows, the first much broader (35/22) than the second. Anterior median eyes somewhat smaller than the laterals. Posterior row of eyes spaced equidistantly. Other eye characters as in the male.

Legs proportionately stouter than in the male, as indicated in the tibial indices. Spines beneath the tibiae 2-2-2. Leg formula 4213.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.80	1.33	2.26	1.66	1.40	9.45 mm.
II	3.16	1.33	2.66	2.00	1.50	10.65 mm.
III	2.73	1.26	2.23	1.76	1.16	9.14 mm.
IV	3.33	1.26	2.60	2.22	1.40	10.85 mm.
Palp	.76	.46	.60		.93	2.75 mm.

Width of patella I, 0.50 mm. Tibial Index, 13.9.

Width of patella IV, 0.43 mm. Tibial Index, 11.1.

LOCALITY.—The above description is based on a male and female from Fish Lake, Sevier County, Utah, taken June 22, 1930 (Gertsch). The species has a wide distribution in the Rocky Mountains of the United States.

***Thanatus canadensis*, new species**

Figures 7 and 49

Although this species is considerably lighter in color than the specimens of *Thanatus coloradensis* described above, it agrees closely in pattern and structure of all parts, the copulatory organs excepted. The bands on the carapace and the elongate marking on the dorsum of the abdomen contrast strikingly with the light bright brown integument. Spines are few and small, confined more or less to the anterior cephalic part of the carapace, and even shorter and more sparse on the abdomen. The median longitudinal band on the carapace is distinct in the female and invaded by few markings, but in the male it does not extend posteriorly beyond the second coxa.

MALE.—Total length, 5.85 mm. Carapace, 3.20 mm. long, 2.90 mm. wide, 1.16 mm. in front. Abdomen, 2.66 mm. long, 2.13 mm. wide.

Eyes in two strongly recurved rows, the first much broader (33/21) than the second. Anterior median eyes smaller, little over a diameter apart and much nearer to the laterals. Posterior row of eyes about equidistantly spaced, the laterals somewhat larger. Median ocular quadrangle scarcely longer (14/13) than broad (apparently much longer), the anteriors closer together. Anterior median eyes over three times as far from the posterior medians as the anterior lateral eyes. Clypeus slightly sloping, as high (14/14) as the median ocular quadrangle.

Spines under the anterior tibiae 2-2-2, under the anterior metatarsi 2-2. Leg formula 4213.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.00	1.33	2.40	2.06	1.66	10.45 mm.
II	3.33	1.33	2.70	2.43	1.73	11.52 mm.
III	2.93	1.23	2.33	2.16	1.56	10.21 mm.
IV	3.16	1.26	2.70	2.70	1.76	11.58 mm.
Palp	1.00	.40	.40		1.13	2.93 mm.

Width of patella, I, 0.46 mm. Tibial Index, 12.3.

Width of patella IV, 0.40 mm. Tibial Index, 10.1.

MALE PALP.—Femur a little shorter than the tarsus, about equal to the patella and tibia taken together. Tibial apophysis a strong spine, with a very slightly oblique placement, nearly parallel to the tibial joint, as long as the tibia from the ventral aspect, seven-twelfths as long as that joint when seen from the lateral view. Bulb expanded, but not so much as in *coloradensis*, the distal embolic portion a fine, long spur.

FEMALE.—Total length, 7.33 mm. Carapace, 3.26 mm. long, 2.90 mm. wide, 1.26 mm. in front. Abdomen, 4.16 mm. long, 2.66 mm. wide.

Agreeing in structural and color characteristics with the male, and only with difficulty separable from the female of *coloradensis*.

TYPE LOCALITY.—Male holotype, female allotype, and several female and immature paratypes from Fawcett, Alberta, May 15-June



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MALE PALPI

Fig. 1. *Thanatus retentus* Chamberlin

Fig. 2. *Thanatus altimontis*, new species.

Fig. 3. *Horodromondes validus*, new species.

Fig. 4. *Thanatus lycosoides* Emerton.

Fig. 5. *Thanatus coloradensis* Keyserling.

Fig. 6. *Thanatus walteri*, new species.

Fig. 7. *Thanatus canadensis*, new species.

Fig. 8. *Thanatus coloradensis* Keyserling, variety.

Fig. 9. *Thanatus rohani*, new species.

3, 1930, sent to this Museum by Dr. William Rowan of the University of Alberta.

***Thanatus lycosoides* Emerton**

Figure 4

This spider is clearly distinct from *Thanatus coloradensis* Keyserling, with which species Emerton has synonymized it. Neither of these can be identified with *Thanatus rubicellus* (Mello Leitao) (*T. rubicundus* Keyserling), which is a much smaller species, characteristically marked, and with only two pairs of spines beneath the anterior tibiae in the female. The only specimens of this species that I have seen came from Oklahoma.

***Thanatus rowani*, new species**

Figure 9

MALE—Integument of carapace dark reddish-brown, with two lateral black bands that do not reach the margins, the intervals between forming a broad longitudinal central band that runs the whole length of the carapace. Sternum, endites, labium, and basal leg joints reddish brown. Femora of legs brown, the distal joints lighter, with a very few black markings. Abdomen very dark, the characteristic longitudinal maculation scarcely visible. Femur of palpus with a linelike streak above.

Total length, 5.00 mm. Carapace, 2.23 mm. long, 2.10 mm. wide, 0.82 mm. in front. Abdomen, 2.66 mm. long, 1.83 mm. wide.

Eyes in two strongly recurved rows, the posterior much broader (24/34) than the anterior. Anterior median eyes only about half the size of the laterals, a diameter and a half apart, about their diameter from the laterals. Posterior median eyes very slightly nearer to each other than to the larger laterals. Median ocular quadrangle longer than wide (16/14), narrowed in front. Anterior median eye about three times as far from the posterior median as the anterior lateral eye. Clypeus slightly sloping, as high as the median ocular quadrangle.

Legs slender, with 2-2 spines under the anterior tibiae, 2-2 under the anterior metatarsi. Leg formula 4213.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2.06	.76	1.76	1.36	1.10	7.04 mm.
II	2.12	.76	1.86	1.60	1.13	7.47 mm.
III	2.06	.78	1.80	1.43	1.10	7.17 mm.
IV	2.33	.80	2.00	1.83	1.20	8.16 mm.
Palp	.73	.33	.33		.93	2.32 mm.

Width of patella I, 0.33 mm. Tibial Index, 13.0.

Width of patella IV, 0.28 mm. Tibial Index, 10.0.

MALE PALPUS.—Femur somewhat shorter than the tarsus, about equal to the patella and tibia taken together. Tibial apophysis a strong spur that is half as long as the tarsus when seen from the lateral aspect. Bulb much expanded but, when viewed ventrally, not much exceeding the cymbial margin at any point. Embolus evenly curved, rather short, lying above a transparent, finger-like conductor.

TYPE LOCALITY.—Male holotype from near Fitzgerald, Alberta, 1930, sent to this Museum by Dr. William Rowan of the University of Alberta.

***Thanatus altimontis*, new species**

Figures 2 and 48

Coloration and pattern as in the other species, the median longitudinal band on the carapace more marked in the female, invaded by a central darker stripe. Abdominal maculation outlined in gray, the lighter color forming a band that continues to the end of the abdomen. Legs distally much lighter, the basal joints streaked.

MALE.—Total length, 4.00 mm. Carapace, 1.90 mm. long, 1.76 mm. wide, 0.73 mm. in front. Abdomen, 3.00 mm. long, 1.26 mm. wide.

Eyes in two strongly recurved rows, the second much wider (31/21) than the first. Anterior median eyes about two-thirds as large as the laterals, less than a diameter from them, little more than a diameter apart. Posterior eyes subequal, equidistantly spaced. Median ocular quadrangle only slightly longer than broad (29/28), the eyes practically equal in size. Anterior median eye nearly three times as far from the posterior median as the posterior lateral eye. Clypeus slightly sloping, as high as the median ocular quadrangle.

Legs slender, the anterior tibiae with 2-2-2 spines beneath, the metatarsi with 2-2 spines. Leg formula 4231

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.83	.76	1.66	1.33	.93	6.51 mm.
II	2.13	.93	1.83	1.63	1.10	7.62 mm.
III	2.03	.76	1.73	1.50	.93	6.95 mm.
IV	2.26	.76	2.00	1.86	1.20	8.08 mm.
Palp	.50	.30	.30		.53	1.63 mm.

Width of patella I, 0.26 mm. Tibial Index, 10.7.

Width of patella IV, 0.25 mm. Tibial Index, 9.0

MALE PALPUS.—Femur about as long as the tarsus, nearly equal to the patella and tibia taken together. Tibial apophysis a strong spur, rather acutely ended, four-sevenths as long as the tarsus when seen from below. Bulb little expanded, but exceeding the lateral cymbial margin distally, the embolus a short, pointed spur.

FEMALE.—Total length, 4.30 mm. Carapace, 3.20 mm. long, 3.00 mm. wide, 0.93 mm. in front. Abdomen, 2.43 mm. long, 1.50 mm. wide.

Eyes as in the male, but the posterior medians more widely separated (12/8) than their distance from the slightly larger laterals. Median ocular quadrangle as broad as long, the eyes subequal.

TYPE LOCALITY—Male holotype and female allotype from Smith's Fork Canyon, Cokeville, Wyoming, August 21, 1931 (Gertsch)

***Thanatus walteri*, new species**

Figures 6 and 47

Carapace brown in the male, very much streaked with darker markings, completely lacking the characteristic median lighter band of the other species. Femora

and patellae concolorous with the carapace, with lighter streaks above, the distal leg joints light brown. Abdomen grayish brown above, the median maculation faintly indicated, the venter dark gray. Female lighter in color, lacking the median lighter band on the carapace, legs little lighter in color than the carapace, the basal joints with black streaks above.

MALE.—Total length, 2.90 mm. Carapace, 1.40 mm. long, 1.26 mm. wide, 0.60 mm. in front. Abdomen, 1.66 mm. long, 1.00 mm. wide.

Both rows of eyes recurved but not so much as in the other members of the genus, the anterior row much narrower (17/27) than the posterior. Anterior median eyes smaller, about one and one-half diameters apart, no more than half their diameter from the laterals. Posterior eyes subequal and equidistant. Median ocular quadrangle as broad as long, the eyes about equal. Anterior median eye about three times as far from the posterior median as the anterior lateral. Clypeus slightly sloping, only about eight-elevenths as high as the median ocular quadrangle.

Legs moderately slender, the spines under the anterior tibiae 2-2, under the metatarsi 2-2. Leg formula 2413.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.10	.50	.93	.80	.56	3.89 mm.
II	1.26	.56	1.03	.86	.60	4.31 mm.
III	1.10	.50	.90	.80	.53	3.83 mm.
IV	1.23	.50	.93	.93	.56	4.15 mm.
Palp	.46	.16	.16		.50	1.28 mm.

Width of patella I, 0.20 mm. Tibial Index, 14.0

Width of patella IV, 0.20 mm. Tibial Index, 14.0.

MALE PALPUS.—Femur about as long as the tarsus, somewhat longer than the patella and tibia taken together. Tibial apophysis a very short spur on the outer side, subventral in position. Bulb somewhat expanded, the embolus a heavy spur twisted at the end.

FEMALE.—Total length, 3.66 mm. Carapace, 1.53 mm. long, 1.40 mm. wide, 0.66 mm. in front. Abdomen, 2.16 mm. long, 1.50 mm. wide.

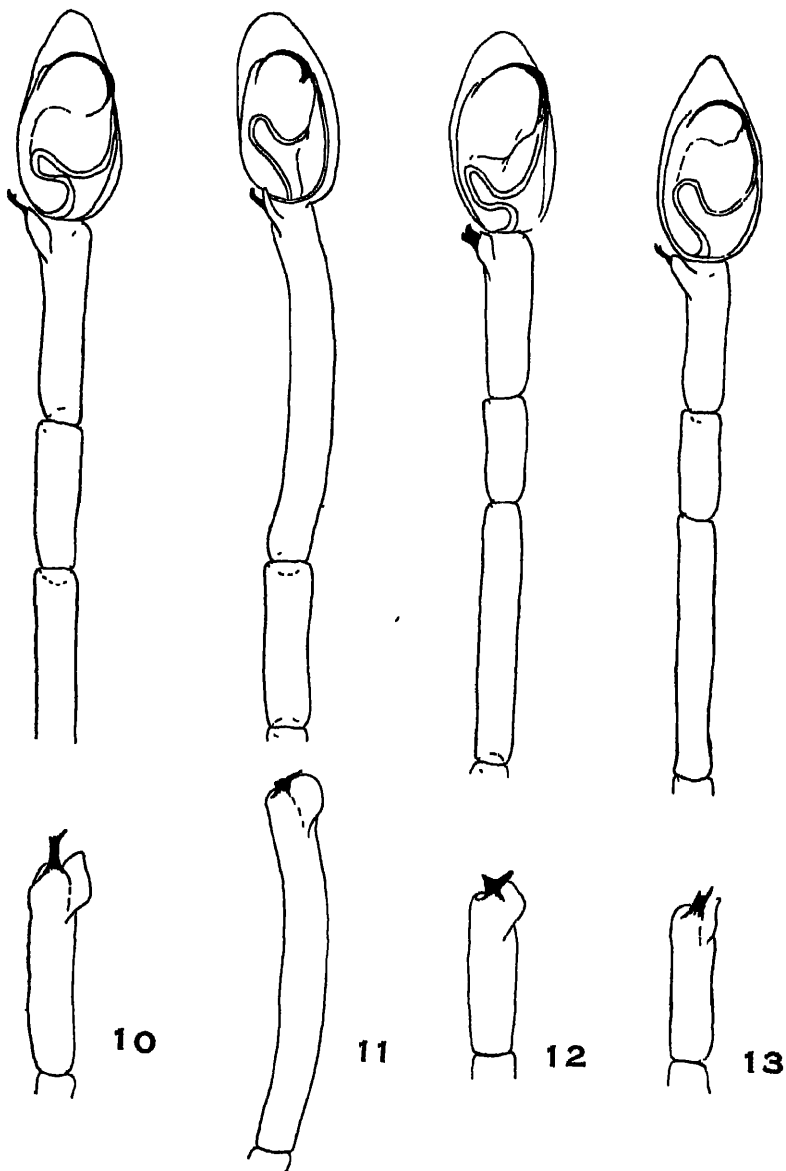
The female agrees structurally with the male and is easily separated from all other species of *Thanatus* by the much narrower clypeus.

TYPE LOCALITY.—Male holotype and female allotype from Montpelier, Bear Lake County, Idaho, taken August 18, 1931, by Walter E. Gertsch, for whom the species is named. A male paratype from Salt Lake City, Utah, July 28, 1931 (Gertsch) is somewhat larger than the type.

TIBELLOMIMUS, new genus

A philodromid genus allied to *Philodromus* and *Philodromoides*.

Carapace much longer than broad (36/29), depressed throughout, the sides subparallel, the front abruptly constricted to half the greatest width. Sternum longer than broad, weakly truncate behind. Labium longer than broad, gradually narrowed distally, subtriangular. Area of eyes very broad, the posterior row nearly as wide as the carapace. Anterior row of eyes shorter than the posterior (28/33), moderately recurved, the eyes subequal, the medians only slightly nearer the laterals



MALE PALPI

Fig. 10 *Tlilanebo texanus*, new species.

Fig. 12 *Tlilanebo californicus*, new species

Fig. 11. *Tlilanebo macyi*, new species.

Fig. 13. *Tlilanebo cockerelli* (Bryant).

(6 5/8) than their distance from each other. Posterior row of eyes slightly recurved, the medians three diameters from the much larger laterals, three times as far from each other. Posterior lateral eyes on conspicuous tubercles, much larger than the others. Clypeus about one and one-half times ($2\frac{5}{4}$) as high as the diameter of an anterior median eye. Median ocular quadrangle much broader than long ($21/8$), the anterior eyes, much nearer together, half as far apart as the slightly smaller posterior eyes. Legs scopulate, 2413, the first tibia with 2-2-2, the second with 2-1-2-2 spines beneath, the metatarsi with 2-2-2 spines beneath (the apical pair considered as ventral).

GENOTYPE.—*Tibellomimus lineatus*, new species.

The narrow clypeus, the flat carapace, which is considerably longer than broad, and the great separation of the posterior median eyes are characters which will easily serve to separate this interesting genus from *Philodromus*. It further differs from *Philodromodes* in having three rather than five pairs of spines under the anterior tibiae.

Tibellomimus lineatus, new species

FEMALE.—Total length, 3.70 mm. Carapace, 1.16 mm long, 0.93 mm. wide, 0.46 mm. in front. Abdomen, 2.50 mm long, 0.95 mm. wide.

Cephalothorax clothed with few hairs, the region of the lateral eyes with a few strong spines. Carapace pale yellow, the sides with a brown submarginal band, the interval between forming a broad, light longitudinal band as wide as the first eye row. Eye tubercles white. Sternum, labium, and endites nearly white in color, immaculate. Legs concolorous with the carapace, the prolateral and retrolateral surfaces with a narrow band that is distinct on the femora but fades out completely on the metatarsal and tarsal joints. Abdomen provided with a sparse covering of inconspicuous appressed hairs and a few spines on the dorsum. Dorsum of abdomen dull yellow, with the broad median longitudinal band and the lateral darker bands continuous with those on the carapace, the sides white below the brown bands, the venter gray.

Eyes as in the generic description.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.16	.50	.93	.83	.53	3.95 mm.
II	1.36	.56	1.06	1.00	.60	4.58 mm.
III	1.16	.46	.90	.80	.50	3.82 mm.
IV	1.46	.53	.93	.86	.53	4.31 mm.

TYPE LOCALITY.—Female holotype and paratype from Dunedin, Florida, December 15-January 8, 1925-1926 (W. S. Blatchley, collector), the holotype to be deposited in the Cornell Collection.

Horodromodes, new genus

A philodromid genus allied to *Horodromus* and *Gephyra*

Carapace broader than long ($35/28$), flattened, about equal in height throughout, the front truncate, narrowed rather abruptly to four-elevenths of the greatest width. Sternum much broader than long ($33/27$), broadly truncate in front, the sides weakly rounded, caudally truncate between the fourth coxa, the separation at that point

being equal to the length of the last coxa. Anterior row of eyes strongly recurved, the medians smaller, more than a diameter apart ($2\frac{5}{4}$), about a diameter from the laterals. Posterior row of eyes slightly recurved, the medians smaller, over two diameters apart ($\frac{3}{7}$), scarcely two diameters from the laterals. Median ocular quadrangle much narrowed in front, as broad as long, the posterior median eyes slightly larger. Posterior lateral eyes larger than the anterior lateral. Clypeus about twice as high as the diameter of an anterior median eye, less than half as high as the median ocular quadrangle ($\frac{5}{12}$). Legs 2314, without scopulae, the anterior tibiae with five pairs of spines beneath, the metatarsi with three pairs.

GENOTYPE—*Horodromoides validus*, new species.

The presence of five pairs of spines beneath the tibiae and the much narrower clypeus separates this genus from *Horodromus* and allied genera.

Horodromoides validus, new species

Figure 3

MALE.—Total length, 2.65 mm. Carapace, 1.46 mm. long, 1.26 mm. wide, 0.53 mm. in front. Abdomen, 1.50 mm. long, 1.00 mm. wide.

Cephalothorax in the poorly preserved specimen showing few hairs and spines above, though they were present on the clypeal margin, the lateral margins with both spines and strong hairs. Carapace brown, the well-defined cephalic and thoracic sutures outlined in black. Eyes on conspicuous black tubercles. Sternum, coxae, and femora yellow, immaculate, the distal leg joints slightly darker. Legs clothed with fine hairs and strong spines, showing indistinct basal, middle, and distal annulae on the femora, the distal joints lacking the medial band. Abdomen imperfect, nearly black, showing no signs of a pattern.

Eyes as in the generic description above.

Legs 2314, the first three tibiae with five pairs of spines beneath.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.50	.60	1.33	1.10	.76	5.29 mm.
II	2.00	.70	1.66	1.43	.90	6.69 mm.
III	1.83	.63	1.53	1.26	.76	6.01 mm.
IV	1.53	.46	1.16	1.03	.66	4.84 mm.

PALPUS.—Femur as long as the tibia and metatarsus taken together. Tibia with a short, sharp spur on the retrolateral side. Tarsus rather heavy, rounded, about as long as broad, the organ approximating that of some species of *Philodromus*, the details of the embolus and bulb best shown in a figure.

TYPE LOCALITY.—Male holotype from Scottsdale, Arizona (Britcher Collection).

TITANEBO, new genus

A philodromid genus allied to *Ebo* and *Philodromus*.

Carapace as broad as long, rather low. Anterior row of eyes slightly recurved, the medians much larger, less than a diameter apart, about one-third of a diameter from the laterals. Posterior row of eyes wider, very slightly recurved, nearly straight, the eyes subequal, the medians farther apart than their distance from the laterals.

Median quadrangle as long as wide, narrower in front, the anteriors considerably larger than the posteriors. Clypeus near vertical, less than the height of the median ocular quadrangle, scarcely twice the diameter of an anterior median eye. Legs with 2-2 spines under the tibiae, rather long; legs I, III, and IV subequal, the second (II) pair greatly elongated, about twice as long as the first pair, over eight times the length of the carapace in the male.

GENOTYPE — *Titanebo macyi*, new species.

The spiders of this interesting genus are considerably larger than the known species of *Ebo*, but they agree with that genus in having the second legs greatly elongate, in the details of the eye relations, and in the similar palpi. They may be separated from *Ebo* by the much higher clypeus, which is coincident with a much higher carapace. *Ebo mexicana* Banks is congeneric with the species described below.

Titanebo macyi, new species

Figure 11

MALE.—Total length, 4.50 mm. Carapace, 2.06 mm. long, 1.83 mm. wide, 0.83 mm. in front. Abdomen, 2.43 mm. long, 1.66 mm. wide.

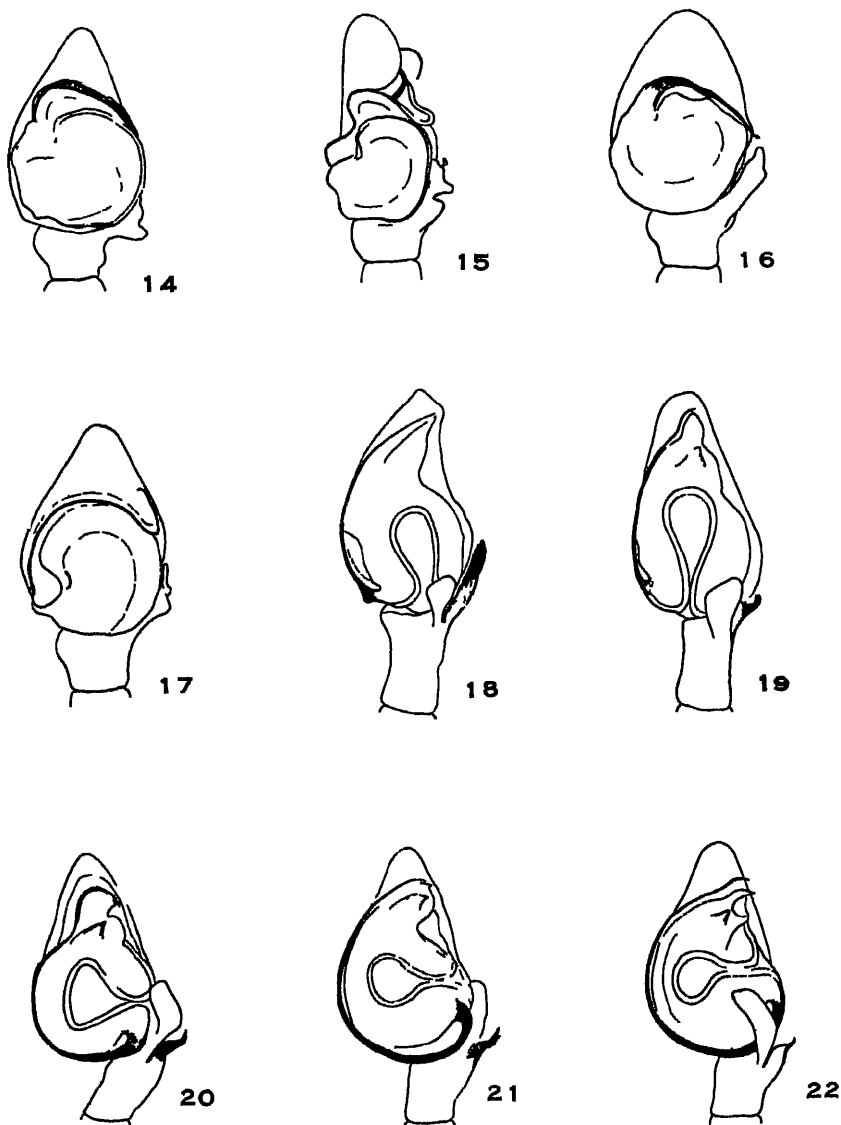
Cephalothorax slightly longer than broad, the cephalic suture conspicuous, the cephalic portion rather high and clearly defined, the dorsum provided evenly with a covering of short fine hairs and sparsely set with short spines. Carapace with an indistinct median lighter band as wide as the second eye row, medially with a V-shaped creamy-white maculation, the apex of which is pointed caudally. Sides of the carapace brown, evenly covered with reticulate black veining. Clypeus only light medially. Eyes black, on conspicuous white-flecked tubercles. Sternum, labium, endites, and basal leg joints dirty yellow in color. Legs yellow, minutely pointed with numerous small brown flecks. Abdomen with a medial dark basal maculation on the dorsum that runs two-thirds its length, is widest near the end and margined in white. Sides of the abdomen brown and white, the venter dirty white and with a narrow black band on each side.

First row of eyes narrower than the second (24/29), recurved, the medians very much larger (6/4) and separated from each other by two-thirds of a diameter, from the laterals, by less than a third. Second row of eyes very slightly recurved, the eyes subequal, the medians about twice as far apart as their distance from the laterals. Median ocular quadrangle very slightly longer than broad, about as wide in front as behind. Clypeus scarcely twice as high as the diameter of an anterior median eye.

Legs 2413, the tibiae armed beneath with two pairs of spines.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	4.13	1.20	3.80	3.63	2.03	14.79 mm.
II	6.06	1.53	6.13	6.20	3.73	23.65 mm.
III	3.50	1.06	3.10	2.93	1.60	12.19 mm.
IV	4.30	1.06	3.73	4.00	1.93	15.02 mm.
Palp	2.33	.80	1.53		.76	5.42 mm.

MALE PALPUS.—Femur as long as the tibia and patella taken together, over three times as long as the tarsus, somewhat longer than the length of the carapace. The



MALE PALPI

Fig. 14. *Misumenops asperatus utanus*,
new variety.

Fig. 15. *Misumenops coloradensis*, new
species.

Fig. 16. *Misumenops viridans* (Banks).

Fig. 17. *Misumenops celer* (Hentz).

Fig. 18. *Philodromus rufus*, Walckenaer.

Fig. 19. *Philodromus placidus* Banks.

Fig. 20. *Philodromus pacificus* Banks.

Fig. 21. *Philodromus mineri*, new species.

Fig. 22. *Philodromus lineatus* Emerton.

whole palpus over twice as long as the carapace. Tibia with two spurs, a ventral colorless rounded lobe and a black spur as in the other species of the genus. Bulbal parts little expanded, the embolus a distal spinelike spur.

FEMALE.—Total length 5.80 mm. Carapace, 2.30 mm. long, 2.13 mm. wide, 1.00 mm. in front. Abdomen, 3.43 mm. long, 2.20 mm. wide.

Median longitudinal band of the carapace more clearly defined than in the male. The dorsum of the abdomen with the basal maculation well indicated, the sides with brown bands, and a caudal V-shaped brown marking, the apex of which is directed posteriorly. Eyes as in the male but the anterior medians a little smaller and separated by about a diameter. Clypeus two and one-half times as high as diameter of an anterior median eye. Spines beneath the tibiae and other structural characters as in the male. Legs 2413.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.13	1.06	2.06	2.16	1.46	10.47 mm.
II	4.76	1.46	4.36	3.73	2.46	16.77 mm.
III	3.03	.93	2.33	1.86	1.16	9.31 mm.
IV	3.73	1.00	2.83	2.60	1.33	11.49 mm.

TYPE LOCALITY.—Male holotype and female allotype from Tillamook County, Oregon (Cape Mearns), August 20, 1931 (R. W. Macy, collector).

***Titanebo texanus*, new species**

Figure 10

MALE.—Total length, 4.00 mm. Carapace, 1.80 mm. long, 1.76 mm. wide, 0.76 mm. in front. Abdomen, 2.25 mm. long, 1.33 mm. wide.

Coloration equivalent to that of the species described above but showing distinct broad bands on the joints of the last two pairs of legs. The clypeus white only on the margin.

First row of eyes recurved, narrower than the second (22/27), the medians much larger than the laterals (4/3), separated from each other by a diameter, a third as far from the laterals. Eyes of the second row slightly recurved, subequal, the medians nearly twice as far apart as their distance from the laterals. Median ocular quadrangle slightly broader than long (16/14), decidedly narrower in front (13/16). Posterior median eyes about equal in size to the anterior laterals. Clypeus twice as high as the diameter of an anterior median eye.

Legs 2143, the tibiae armed beneath with two pairs of spines.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	3.60	1.10	3.56	3.13	1.70	13.09 mm.
II	5.90	1.46	6.30	6.26	3.75	23.67 mm.
III	3.10	.83	2.78	2.46	1.16	10.31 mm.
IV	3.73	.90	3.33	3.26	1.56	12.78 mm.
Palp	1.73	.60	.93		.93	4.19 mm.

MALE PALPUS.—Femur about as long as the tibia and patella taken together, nearly twice as long as the tarsus, nearly equal to the length of the carapace. Tibial spur much longer than in the other species. Bulbal parts as figured.

TYPE LOCALITY.—Austin, Texas. Male holotype and female allotype, the latter in a very poor state of preservation.

***Titanebo californicus*, new species**

Figure 12

MALE.—Total length, 3.66 mm. Carapace, 1.60 mm. long, 1.53 mm. wide, 0.63 mm. in front. Abdomen, 2.10 mm. long, 1.33 mm. wide

Carapace with a median longitudinal white band as wide as and enclosing the eye area in front, narrowing considerably at the cephalic suture and back to the margin. Sides of carapace brown, reticulately veined in black, the margins with a few lighter markings. Clypeus light. Sternum, labium, endites, and legs thickly irrorate with small black spots, the color of the integument of these parts varying from white to yellow. Abdomen with the median basal brown maculation as in the other species, broadly margined in white, the remainder of the dorsum brown, the sides and venter marmorate in black and white.

Eyes of the first row recurved, the medians much larger ($4/3$), separated from each other by fully a diameter, scarcely half a diameter from the laterals. Second row of eyes broader ($27/22$), slightly recurved, the medians twice as far apart as their distance from the laterals. The median ocular quadrangle broader behind ($14/12$), as long as broad, the anterior medians larger. Clypeus equal in height to twice the diameter of an anterior median eye.

Legs 2413, the tibiae armed beneath with two pairs of spines

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2 23	73	2 13	1 76	93	7 78 mm.
II	3 53	1 00	3 40	3 16	1 76	12 85 mm.
III	2 00	66	1 76	1 43	80	6 65 mm.
IV	2 50	66	2 06	1 93	.90	8 05 mm.
Palp	1 13	43	.60		73	2 89 mm.

MALE PALPUS.—Femur as long as the patella and tibia taken together, considerably shorter than the length of the carapace. The whole palpus less than twice the length of the carapace. Tibia with the customary spurs, the ventral a colorless, rounded lobe, the retrolateral black and truncately ended. Embolus a distal curved spine proportionately longer than in the other species.

TYPE LOCALITY.—Male holotype from San Francisco, California (R. F. Sternitzky, collector).

Philodromus Walckenaer***Philodromus mineri*, new species**

Figure 21

MALE.—Total length, 3.30 mm. Carapace, 1.60 mm. long, 1.60 mm. wide, 0.60 mm. in front.

Carapace as long as broad, almost entirely devoid of spines, reddish brown in color, the margins usually a little darker. Abdomen half again as long as broad, dark brown, showing only an indistinct median longitudinal band that caudally fades out and is replaced by chevrons, the venter paler. Legs, palpi, and under side of carapace concolorous with the dorsum, the appendages with indistinct light and dark streaks.

First row of eyes much narrower than the second, moderately recurved, the laterals which are their diameter from the medians only slightly larger, the medians

separated by a diameter and a half. Second row of eyes straighter, broader (30/23), the laterals clearly larger and not half so far apart as are the medians from each other. Median ocular quadrangle much broader than long, about half as wide in front, the eyes subequal. Clypeus slightly sloping, a little higher than the median quadrangle.

Legs 2134, the last pairs about equal, all femora longer than the width of the carapace, the third and fourth metatarsi about equal to it; tibia and patella II scarcely as long as the carapace. Spines under the first tibiae 2-2-2.

TYPE LOCALITY.—Male holotype from Douglas Lake, Michigan, June 7, 1932 (E. L. Miner).

The palpi of the species thought to be *Philodromus pacificus* Banks and *P. rufus* Walckenaer are figured (Figs. 18 and 20).

MISUMENOPS, O. P. Cambridge

Several thomisid spiders originally described from Mexico are now known to extend into the southwestern United States. In this genus notable examples of such occurrence are *Misumenops dubius* Keyserling and *M. volutus* Cambridge, the first of which is common in Texas, New Mexico, Oklahoma, and Colorado. The latter species is recorded from Colorado on the basis of a single male, which agrees perfectly with specimens from Mexico. In the genus *Misumenoides* a single Mexican species is so far known to be indigenous to Colorado, *M. annulipes* (Cambridge).

Misumenops asperatus utanus, new variety

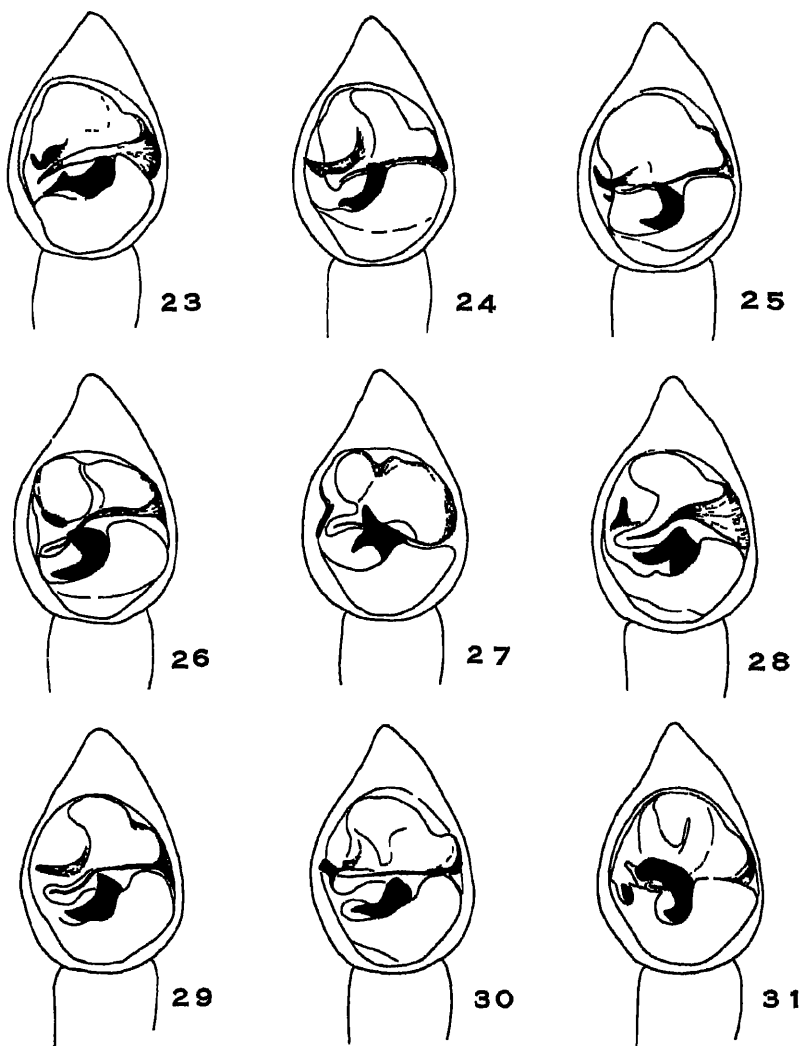
Figure 14

MALE.—Total length, 4.00 mm. Carapace, 1.76 mm. wide, 1.76 mm. long.

Carapace varying from dull to bright yellow, with two dorsal brown bands and a median lighter longitudinal band, the latter with a V-shaped creamy white marking in the middle, the sides of the carapace yellow, the margins with a fine black line. Eye tubercles and most of the area of the eyes creamy white. Legs concolorous with the carapace, bright to dull yellow, the last two pairs of legs sparsely pointed in red and unbanded, the first pairs with narrow rings distally on the femur and patella and basally on the tibia, and with broader rings distally on the tibia, metatarsus, and tarsus, the femora of the first two pairs rather thickly and evenly flecked in red. Palpus white above. Abdomen gray to white, with or without a basal reddish marking and invariably with two distal serrate red or black bands. Under side of whole animal light, immaculate, sparsely punctate, or rarely with a darker marking at the middle of the abdomen.

Eyes in two recurved rows, the anterior medians only slightly nearer together, somewhat smaller than the laterals, the posterior medians slightly nearer together than their distance from the somewhat larger laterals. Median ocular quadrangle about as broad as long, a little narrower in front, over one and one-half diameters apart, the anterior eyes clearly much larger.

Male palpus agreeing with *M. asperatus* (Hentz) in being considerably heavier than in other species of the genus, very thick and robust, the embolus a heavy, broad tube that originates distally on the inner side, curves across the ventral face near the



MALE PALPI

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| Fig. 23. <i>Pardosa umanaki</i> , new species. | Fig. 27. <i>Pardosa ontariensis</i> , new species. |
| Fig. 24. <i>Pardosa lengi</i> , new species. | Fig. 28. <i>Pardosa telonensis</i> , new species. |
| Fig. 25. <i>Pardosa furcifera</i> (Thorell). | Fig. 29. <i>Pardosa varians</i> , new species. |
| Fig. 26. <i>Pardosa townsendi</i> , new species. | Fig. 30. <i>Pardosa modica</i> (Blackwall) |
| Fig. 31. <i>Pardosa fuscula</i> (Thorell) | |

distal end, and then makes a broad spiral turn on the flattened retrolateral margin of the cymbium, the distal acuminate tip of the embolus exceeding the margin.

TYPE LOCALITY.—Male holotype, female allotype, male and female paratypes from Salt Lake City, Utah (City Creek Canyon), taken in sweeping spring composites. Paratypes of both sexes from Zion National Park, Utah.

This is clearly the western representative of the eastern species regarded as *Misumenops asperatus* (Hentz) and may only be accorded varietal rank. It is a larger spider, has the anterior median eyes more widely separated, shorter legs, and the palpus proportionately broader. Petrunkevitch, in his paper on Porto Rican spiders, was not dealing with the true *asperatus*, which probably does not occur in that locality. Emerton has given a good figure of the male palpus of this distinctive species in his paper on 'New England Spiders of the Family Thomisidae' (1892 Trans. Connecticut Academy, VIII).

Misumenops coloradensis, new species

Figures 15 and 46

MALE.—Total length, 2.65 mm. Carapace, 1.30 mm. long, 1.30 mm. wide.

Pattern as in the foregoing species, the color in general much duller, only the distal broad bands on the tibiae and metatarsi of the anterior legs well marked. Structurally equivalent to any other species of the genus, a group that is so closely related that only characters of the palpi and slight differences in the eye relations seem significant. Eyes as in *M. ulanus*, new variety.

Palpus of the *asperatus* type but differing in the extreme modification of the cymbium for the reception of the long curved embolus, the distal fine tip of which greatly exceeds the margin, a large black tooth present between the curved embolic portion on the retrolateral surface. The broad tibial apophysis is provided with a slenderer process that projects dorsally. Other details of the ventral surface of the palpus are shown in the figure.

TYPE LOCALITY.—Male holotype, female allotype, and paratypes of both sexes from Colorado. Female paratypes from Grand Canyon (North Rim), Arizona, and Kanab, Utah.

PARDOSA C. Koch

The species described below pertain chiefly to that interesting complex termed the Glacialis Group. The use of a single specific name to designate such a heterogeneous mixture of anomalous forms has always seemed to me to be a challenge to the validity of the criteria on which specificity in spiders has been founded,—the structure of the palpi and epigyna. In a sweeping gesture Emerton synonymized all of Thorell's species under two names, and it has been the practice of American arach-

nologists to concur in his conclusions. Some of the figures of these so-called variations by Emerton were fortunately based on the original specimens described by Thorell. With this important aid I have been able correctly to place all of Thorell's species in this group except *labradorensis*. As this name was based upon material that had previously been dried, it now would seem to be impossible ever to place it correctly. Undoubtedly it is one of the species described below and quite possibly *Pardosa lengi*, new species, which is common in Labrador, but the connection of this female with the one described by Thorell, which I regard as the type, seems too risky at the present time. Blackwall's *modica* is probably the species Emerton described as *brunnea*.

***Pardosa ontariensis*, new species**

Figure 27

MALE.—Total length, 6.70 mm. Carapace, 3.35 mm long, 2.30 mm. wide. Abdomen, 3.35 mm. long, 1.85 mm. wide.

Carapace nearly black, with a median longitudinal lighter band that is indistinct in front where it is nearly as wide as the third eye row, clearly indicated but much narrowed behind, enclosing a median linelike streak continuous with the longitudinal thoracic sutures. Sides with a lateral lighter band that does not attain the margin, leaving a narrow black marginal band. Sternum, labium, and endites black, the coxae with lighter basal markings. Legs basally black, the terminal joints becoming lighter, these latter with black marks and streaks. Abdomen black, basally with the characteristic lighter marking, otherwise with few lighter markings. Venter lighter, medially with a broad longitudinal dull yellow band that anteriorly is invaded by brown markings, the margins with circular lighter maculations. Spinnerets black.

Eyes of the first row slightly procurved, the medians separated by nearly a diameter, more than twice as large as the small laterals and separated from them by less than a diameter of the laterals. Clypeus equal to little more than one and one-half times the diameter of an anterior median eye. Second row of eyes wider than the first (32/24), but narrower than the third eye row (32/42), separated from each other by a diameter, farther from the third eye row (17/11). Posterior eyes separated from each other by nearly four diameters (33/9), smaller than the eyes of the middle row (11/9).

Tibia and patella I, 3.33 mm. long.

Tibia and patella IV, 3.80 mm. long.

Spines under the tibiae 2-2-2.

Palpus thickly covered with strong black hairs. Femur a little longer than the tibia and patella taken together, which are subequal. Tarsus as long as the tibia and patella. Scopus a short thick process with three spurs.

TYPE LOCALITY.—Male holotype from St. Thomas, Ontario, August, 1928 (Lorne E. James); male paratype from Logan Canyon, Utah, July 2, 1927 (R. V. Chamberlin); male paratype from Medicine Hat, Alberta, July (Carr).

Pardosa tetonensis, new species

Figures 28 and 38

MALE.—Total length, 5.80 mm. Carapace, 2.86 mm. long, 2.20 mm. wide.

Carapace nearly black, with the customary narrow median longitudinal lighter band and submarginal side stripes as in other species of the group. Eye region black and shining. Sternum, labium, and endites dark. Legs yellow, the basal joints darker and lined above with narrow black stripes. Abdomen concolorous with the carapace, basally with a light narrow median maculation running half its length, the venter somewhat lighter. The spines are strong and rather long. Palpus black.

Eyes of the first row slightly procurved, the medians separated by two-thirds of a diameter, slightly larger than the laterals, from which they are separated by less than a radius. Clypeus light in color, twice as high as the diameter of an anterior median eye. Second row of eyes wider than the first (30/20), narrower than the third (30/42), separated from each other by practically a diameter (18/21), a diameter and a half away from the third eye row. Posterior eyes separated by about four diameters, smaller (8/11) than the eyes of the second row.

Tibia and patella I, 2.66 mm. long.

Tibia and patella IV, 3.33 mm. long.

Spines under the tibiae 2-2-2.

Palpus thickly covered with strong black hairs, the femur slightly longer than the tarsus or the tibia and patella taken together. Scopus a short process with a basal hump and a strong spur directed toward the retrolateral margin.

A female that comes from the same locality and seems to belong with the male has the median longitudinal band on the carapace much broader and truncated anteriorly just behind the third eye row. The marginal bands are also much expanded, leaving a marginal black band no more than a third as wide, the lighter stripes continuous with the clypeus. The venter of the abdomen is light gray, the sides speckled, the dorsum with the characteristic maculation as in the male. The legs are darker than in the male and have indistinct dark annulae. The epigynum resembles that of *Pardosa modica* (Blackwall).

TYPE LOCALITY.—The male holotype and female allotype are from Slough Creek, Yellowstone National Park, Wyoming, collected by Walter E. Cortsch, August, 1930.

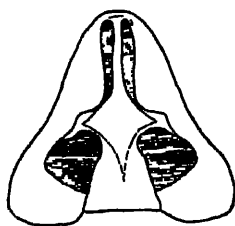
Pardosa varians, new species

Figures 29 and 32

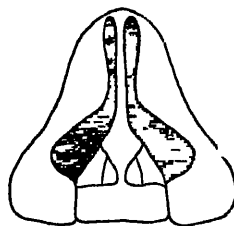
MALE.—Total length, 5.30 mm. Carapace, 2.73 mm. long, 2.06 mm. wide. Abdomen, 2.80 mm. long, 1.76 mm. wide.

The male of this species differs but little from the foregoing species in color markings. The dorsal band is indistinct, the submarginal band on the carapace is continuous with the light clypeus, and the venter of the abdomen is slightly darker.

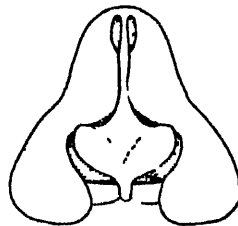
Eyes of the first row slightly procurved, the medians separated by scarcely a diameter, less than a radius from the somewhat smaller laterals. Clypeus equal to one and one-half times the diameter of an anterior median eye. Second row of eyes broader than the first row (29/20), narrower than the third (29/40), separated from each other by one diameter, about a diameter and a half from the smaller eyes of the third row, which are four diameters apart.



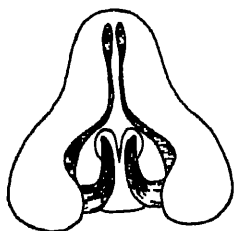
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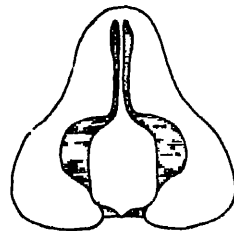
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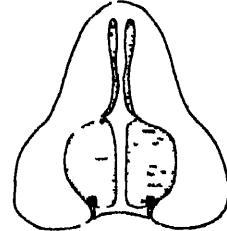
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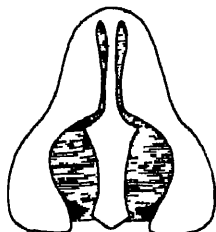
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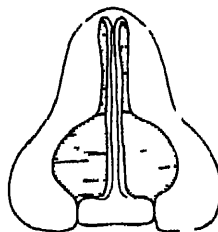
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FEMALE EPIGYN

Fig. 32. *Pardosa varians*, new species.

Fig. 33. *Pardosa furcifera* (Thorell).

Fig. 34. *Pardosa lengi*, new species.

Fig. 35. *Pardosa ourayensis*, new species.

Fig. 36. *Pardosa anomala*, new species.

Fig. 37. *Pardosa wasatchensis*, new species.

Fig. 38. *Pardosa tetonensis*, new species.

Fig. 39. *Pardosa johanseni*, new species.

Fig. 40. *Pardosa concinna* (Thorell).

Tibia and patella I, 2.26 mm. long.

Tibia and patella IV, 3.00 mm. long.

Spines under the tibiae 2-2-2

The palpus of this species closely approximates that of *Pardosa lengi*, new species, and can be separated only by characters that are easier to show in a figure than to illustrate satisfactorily by verbal description.

FEMALE.—Total length, 5.80 mm. Carapace, 2.73 mm. long, 2.16 mm. wide. Abdomen, 3.35 mm. long, 2.16 mm. wide.

Carapace lighter than in the male, the eye region nearly black, the median longitudinal band well defined, originating just behind the last eye row and constricted to the posterior margins. Lateral bands continuous with the clypeus, bright yellow, about double as wide as the brown marginal bands. The intervals between the light bands form two dark areas that are continuous in front with the dark eye region. Sternum dark. Labium, endites, and basal leg joints light brown, with a few lighter areas. Legs distally lighter, the femora mottled with brown, the basal joints with indistinct dorsal lineation. Basal maculation of the dorsum of the abdomen continuous with the median light stripe on the carapace, about two-fifths the length of the abdomen, the area behind with alternate dark and light areas that under low power appear as indistinct chevrons. Venter of the abdomen pale brown.

Eyes of the first row very slightly recurved, the medians separated by two-thirds of a diameter, less than a radius from the slightly smaller laterals. Clypeus equal in height to about one and one-half times the diameter of an anterior median eye. Second row of eyes wider than the first (29/33) but narrower than the posterior eyes (29/34), separated from each other by four diameters (8.5/32), smaller than the eyes of the second row (8.5/11).

Tibia and patella I, 2.46 mm. long.

Tibia and patella IV, 3.30 mm. long.

Spines on legs stout and rather long, the tibiae with 2-2-2 spines beneath.

Epigynum closely resembling that of *Pardosa furcata* (Thorell) but differing in details best shown by a figure.

TYPE LOCALITY.—Male holotype, female allotype, and male and female paratypes from the mouth of Coppermine River, Northwest Territory, June 8-13, 1925 (Hearne). Types in the collection of the Entomological Division of the Department of Agriculture, Ottawa, Ontario, Canada; paratypes deposited in the collection of The American Museum of Natural History.

Pardosa johanseni, new species

Figure 39

FEMALE.—Total length, 7.66 mm. Carapace, 3.26 mm. long, 2.56 mm. wide. Abdomen, 4.50 mm. long, 3.33 mm. wide.

Carapace light brown to black, the eye region darker than the area enclosed by the characteristic bands of the dorsum. The dorsal band distinct only near the median cephalic suture and back to the margin, the lateral bands continuous with the clypeus, somewhat dentate, twice as wide as the marginal black bands. Sternum dark. Labium, endites, and coxae concolorous with the dull yellow legs, the latter with few

markings. Basal lighter maculation on the dorsum of the abdomen running half the length of the abdomen, the remainder uniform light brown. Venter little lighter than the dorsum.

Eyes of the first row slightly procurved, the slightly larger median eyes separated by two-thirds of a diameter and less than a radius from the laterals. Clypeus over four times as high as the diameter of an anterior median eye. Second row of eyes wider than the first (34/26) but narrower than the third eye row (34/45), separated by one diameter, farther from the eyes of the last row (16/12). Posterior eyes separated from each other by nearly four diameters, smaller than the eyes of the second row (10/12).

Tibia and patella I, 3.00 mm. long.

Tibia and patella IV, 4.00 mm. long.

Spines under the tibiae 2-2-2.

TYPE LOCALITY.—Female holotype from Collinson, Alberta, June 20, 1914 (Johansen); paratypes from Bernard Harbor. Type in the collection of the Entomological Division of the Department of Agriculture, Ottawa, Ontario, Canada; paratype deposited in the collection of The American Museum of Natural History.

Pardosa townsendi, new species

Figure 26

MALE.—Total length, 6.70 mm. Carapace, 3.30 mm. long, 2.50 mm. wide. Abdomen, 3.60 mm. long, 2.30 mm. wide.

A species equivalent in proportions and color to any of the above-described forms, with the median longitudinal band on the carapace nearly obliterated by the invasion of dark brown lateral markings, the submarginal lateral bands continuous with the clypeus and only as wide as the marginal darker bands. Sternum dark, the labium, endites, and coxae somewhat lighter, with a few dull yellow maculations. Legs medium brown, little lighter than the carapace. Abdomen concolorous with the carapace, the basal lighter marking poorly defined and ending near the middle of the dorsum, the venter dark.

Eyes of the first row slightly procurved, the medians separated by scarcely a diameter, less than a radius from the subequal laterals. Clypeus little more than twice as high as the diameter of an anterior eye. Second row of eyes wider than the first (33/23) but narrower than the posterior row (33/47), separated by a diameter, farther from the posterior row (16/12). Posterior eyes separated from each other by a little less than four diameters (9.5/36), smaller than the eyes of the second row (9.5/12).

Tibia and patella I, 3.06 mm. long.

Tibia and patella IV, 3.66 mm. long.

Spines under the tibiae 2-2-2.

Palpus moderately clothed with strong black hairs.

TYPE LOCALITY.—Male holotype from Blanc Sablon, southern Labrador, July, 1915 (Townsend), in the collection of the Division of Entomology, Department of Agriculture Ottawa, Ontario, Canada.

***Pardosa umanaki*, new species**

Figures 23 and 43

MALE.—Total length, 4.80 mm. Carapace, 2.68 mm. long, 2.10 mm. wide. Abdomen, 2.33 mm. long, 1.50 mm. wide.

Carapace dark brown to black, the eye region darker, the median longitudinal band poorly defined, the lateral lighter bands twice as wide as the black marginal bands, but not continuous with the clypeus, which is black. Sternum, labium, endites, and basal leg joints dark brown, the remaining leg segments a lighter brown, showing indistinct darker markings. Abdomen with a few white hairs basally, the usual lighter maculation present on the dorsum practically obliterated in the imperfect specimen.

Eyes of the first row clearly procurved, the larger medians separated by less than a diameter from each other, less than a radius from the laterals. Clypeus equal to one and one-half times the diameter of an anterior median eye. Second row of eyes wider than the first row (32/21), narrower than the third (32/41), separated by scarcely a diameter, and farther from the third row (16/11). Posterior row of eyes separated from each other by about four diameters, smaller than the middle eyes (9/11).

Tibia and patella I, 2.95 mm. long

Tibia and patella IV, 3.30 mm. long

Spines under the tibiae 2-2-2

Palpus with a moderately heavy covering of strong brown hairs, characterized particularly by the distinctive scopus.

FEMALE.—Total length, 5.50 mm. Carapace, 3.16 mm. long, 2.33 mm. wide. Abdomen, 2.66 mm. long, 1.66 mm. wide.

Coloration and structure as in the male. This species is characterized by the much expanded, platelike epigynum, which, though very much like that of *glacialis*, differs in important details from that species.

TYPE LOCALITY.—Males and a single mature female from Umanak, Greenland (64°, 40' N., 50°, 40' W.), June 6, 1915 (Ekblaw and Tanquary).

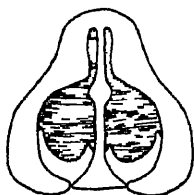
DISCUSSION.—The identity of Thorell's *glacialis* has never been very certain, in spite of the frequent use of the name for description and locality citation. Thorell's specimens came from Greenland, and most of the Canadian representatives so often referred to it (especially by Emerton) belong with other species of this difficult group. However, I have seen one specimen from Canada that seems definitely to be referable to the true *glacialis* of Thorell.

***Pardosa lengi*, new species**

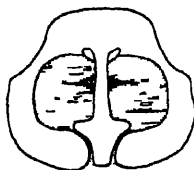
Figures 24 and 34

MALE.—Total length, 5.80 mm. Carapace, 2.86 mm. long, 2.00 mm. wide. Abdomen, 2.66 mm. long, 1.50 mm. wide.

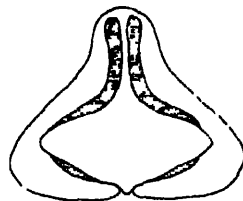
Carapace dark brown, the lighter dorsal longitudinal band broadest just behind the eyes, rather abruptly constricted near the cephalic suture and then more gradually



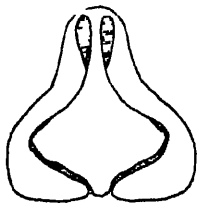
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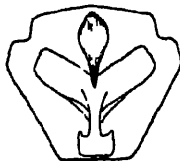
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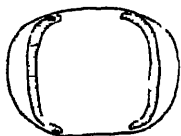
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FEMALE EPIGYNA

Fig. 41. *Pardosa modica* (Blackwall).

Fig. 46. *Musumenops coloradensis*, new species

Fig. 42. *Pardosa fuscata* (Thorell).

Fig. 43. *Pardosa umanaki*, new species.

Fig. 47. *Thanatus walieri*, new species.

Fig. 44. *Pardosa glacialis* (Thorell)

Fig. 48. *Thanatus altimontis*, new species.

Fig. 45. *Pardosa orophila*, new species.

Fig. 49. *Thanatus canadensis*, new species

narrowed caudally to the margin. Submarginal lighter bands continuous with the clypeus and scarcely twice as wide as the narrow marginal brown band. Sternum black. Labium, endites, coxae, and legs lighter, the legs with darker streaks dorsally on the femora. Abdomen light to dark brown, the basal maculation well defined and margined in black, with a few indistinct paired black spots behind.

First row of eyes practically straight, the medians a little larger and separated from each other by little more than half a diameter, half as far from the laterals. Clypeus about as high as one and one-half times the diameter of an anterior median eye. Second row of eyes wider than the first (29/20) but narrower than the third (39/29), separated by scarcely a diameter, half again as far from the eyes of the third row (9/14). Posterior eyes separated from each other by four diameters, smaller than the eyes of the second row (7/10)

Tibia and patella I, 2.46 mm. long.

Tibia and patella IV, 3.16 mm. long

Spines under the tibiae 2-2-2.

FEMALE.—Total length, 6.50 mm. Carapace, 3.00 mm. long, 2.20 mm. wide. Abdomen, 3.66 mm. long, 2.33 mm. wide.

The female of this species agrees in all color details with the male, but because of its larger size it usually appears slightly lighter throughout. The bands on the carapace are distinct, and the dorsum of the abdomen has the four or five small paired spots at the sides on the caudal margin as in the male. In this sex the clypeus is twice as high as in the male, equal to over three times the diameter of an anterior median eye.

Tibia and patella I, 2.80 mm. long.

Tibia and patella IV, 3.50 mm. long.

Spines under the tibiae 2-2-2.

TYPE LOCALITY.—Male holotype and female allotype from Chateau Bay, Labrador, July, 1927 (Leng). Male and female paratypes from Battle Harbor, Labrador, July 30, 1912 (Engelhart).

Pardosa wasatchensis, new species

Figure 37

FEMALE. Total length, 6.00 mm. Carapace, 3.00 mm. long, 2.26 mm. wide. Abdomen, 3.00 mm. long, 2.00 mm. wide.

Carapace light to dark brown, with a narrow median longitudinal lighter band beginning at the middle of the carapace and ending just before the caudal margin, the customary submarginal lighter bands as wide or wider than the black margin and continuous with the light clypeus. Sternum, labium, endites, and coxae light brown, the latter basally lighter. Femora of the legs marked with black, the distal joints becoming lighter, the dorsal surfaces of the basal joints with alternate light and dark streaks above. Abdomen light brown above, the basal dash distinct, the venter light yellow.

Eyes of the first row slightly procurved, the medians separated by a diameter, less than a radius from the smaller laterals. Clypeus about twice the diameter of an anterior median eye. Second row of eyes wider than the first (33/21) but narrower than the third (33/44), separated by scarcely a diameter (11/12), farther from the

eyes of the third row (11/16). Posterior eyes separated from each other by over three diameters (10/34), smaller than the eyes of the middle row.

Tibia and patella I, 2.53 mm. long.

Tibia and patella IV, 3.00 mm. long.

Spines under the tibiae 2-2-2.

TYPE LOCALITY.—Female holotype and paratypes from Fish Lake, Sevier County, Utah, June 22, 1930 (Gertsch).

***Pardosa anomala*, new species**

Figure 36

FEMALE.—Total length, 6.40 mm. Carapace, 3.20 mm. long, 2.43 mm. wide. Abdomen, 3.30 mm. long, 2.30 mm. wide.

Carapace black to dark brown, with a median longitudinal lighter band best defined at the cephalic suture, and continuing caudad to the margin, anteriorly dividing into two tongue-like streaks that approach the third eyes. Lateral streaks continuous with the light clypeus, a little lighter than the marginal band, the light band irregularly dentate and broken at intervals by black patches. Sternum and labium dark. Endites and coxae light brown, basally streaked with yellow. Legs marked with large, irregular maculations basally, the distal joints showing distinct annulae basally, medially, and at the distal extremity, the tarsi lighter. Dorsum of abdomen concolorous with the carapace, the basal lighter marking dimly margined in black, not conspicuous, often covered with white hairs, the venter little lighter.

Eyes of the first row very slightly procurved, the medians separated by one diameter, about a radius from the smaller laterals. Clypeus equal in height to about one and one-half times the diameter of an anterior median eye. Second row of eyes wider than the first row (32/23), narrower than the third (32/43), separated from each other by a diameter, farther from the eyes of the third row (10/15). Eyes of the third row somewhat over three diameters apart, smaller than the middle eyes.

Tibia and patella I, 3.10 mm. long.

Tibia and patella IV, 3.66 mm. long.

Spines under the tibiae 2-2-2.

Epigynum closely resembling that of *Pardosa longi*, new species, but differing in some details. The male is not known, but a large number of females have been taken in the Uintah Mountains of eastern Utah at an altitude of 10,000 feet or more, in which situation they were common in the grassy and wooded areas bordering the numerous lakes. The following species from Colorado is also closely related to *anomala*, but differences in the epigyna are so constant that, for the present at least, I regard them as specific.

TYPE LOCALITY.—Female holotype and female paratypes from the Uintah Mountains of Utah (Mirror Lake and vicinity), August 1, 1931 (Gertsch).

***Pardosa ourayensis*, new species**

Figure 35

FEMALE.—Total length, 6.30 mm. Carapace, 3.38 mm. long, 2.40 mm. wide. Abdomen, 3.00 mm. long, 2.30 mm. wide.

A species equivalent structurally to *Pardosa anomala*, new species, differing in color only in the somewhat greater anterior extension of the median lighter band on the carapace, which is nearly as wide as the third eye row in front and gradually narrowed to the caudal margin. Submarginal light bands of the carapace continuous with the clypeus, deeply dentate, not much wider than the remaining marginal dark band. Legs lacking the indistinct annulae, the basal joints darker. Abdomen with the basal maculation on the dorsum more clearly indicated than in the foregoing species.

Eyes of the first row slightly procurved, the larger medians separated by a diameter from each other, less than a radius from the laterals. Clypeus about two and one-half times as high as the diameter of an anterior median eye. Eyes of the second row broader than the first (31/22) but narrower than the third row (31/41), separated by a diameter from each other, farther from the posterior eyes (11/16). Eyes of the third row separated by scarcely four diameters, smaller than the eyes of the middle row.

Tibia and patella I, 3.00 mm. long.

Tibia and patella IV, 3.50 mm. long.

Spines under the tibiae 2-2-2.

TYPE LOCALITY.—Female holotype and paratypes from Ouray, Colorado, July 13, 1917 (Lutz).

Pardosa uintana, new species

Pardosa uncola EMERTON, 1894, Trans. Conn. Acad. Arts and Sciences, IX, (part), pp. 426-427, Plate III, figures 8c, 8d, and 8f.

MALE.—Total length, 5.10 mm. Carapace, 2.66 mm. long, 2.10 mm. wide. Abdomen, 2.50 mm. long, 1.66 mm. wide.

Carapace almost uniform black, lightened somewhat only at the cephalic suture. Sternum black. Labium, endites, and coxae light brown. Legs distally pale brown, the femora and tibiae a little darker, marked with indistinct black bands. Palpus black. Abdomen little lighter than the carapace, unmarked by any definite pattern, the venter concolorous with the dorsum.

Eyes of the first row slightly procurved, the medians separated by about a diameter, less than a radius from the somewhat smaller laterals. Clypeus twice as high as the diameter of an anterior median eye. Second row of eyes wider than the first (32/21), narrower than the third (32/44), separated by scarcely a diameter, farther from the posteriors (15/10). Eyes of the third row separated from each other by four diameters, smaller than those of the middle row.

Tibia and patella I, 2.66 mm. long.

Tibia and patella IV, 3.20 mm. long.

Spines under the tibiae 2-2-2.

Palpus sparsely covered with black hairs. Tarsus distinctly longer than the tibia (21/16) as seen from above. Details of palpus very much as in *Pardosa mackenziana* (Keyserling), with which species it has been confused, but differing in the much shorter scopus and other details of the bulb.

FEMALE.—Total length, 5.30 mm. Carapace, 2.76 mm. long, 2.06 mm. wide. Abdomen, 2.66 mm. long, 2.00 mm. wide.

What is apparently the female of this species agrees remarkably well with that of *Pardosa mackenziana* (Keyserling). Emerton in his paper on 'Canadian Spiders' (1894, Trans. Conn. Acad. Arts and Sciences, IX, pp. 425-426, Plate III, figure 8) has figured both sexes of *mackenziana* and this new species under the name of *Pardosa uncata* (Thorell), which is now considered a synonym of Keyserling's species.

TYPE LOCALITY.—Utah Mountains, eastern Utah, August 1, 1931, male holotype, female allotype, and male and female paratypes (Gertsch). This species and *Pardosa mackenziana* (Keyserling) are common in the Rocky Mountains of the United States and Canada, ranging from six to twelve thousand feet in altitude. I have seen both from Utah, Idaho, Colorado, Wyoming, Montana, and Alberta.

***Pardosa orophila*, new species**

Figure 45

Female.—Total length, 3.65 mm. Carapace, 1.90 mm. long, 1.50 mm. wide. Abdomen, 1.80 mm. long, 1.40 mm. wide.

Carapace with an irregular median band beginning squarely between the second and third eye rows, rapidly expanded at the posterior, constricted at the middle of the carapace, and continuing caudally to the margin. Sides of the carapace dark brown, with a submarginal light band continuous with the clypeus, the margins irregularly broken by dark maculations. Sternum, labium, endites, and coxae light yellow. Legs indistinctly annulate in black, lighter distally, the femur irregularly suffused with black. Dorsum of abdomen dark brown on the sides, medially with a bright yellow, longitudinal band that runs the whole length, in which area there is present a basal darker dash that ends at the middle of the dorsum. Venter gray.

First row of eyes slightly procurved, the medians larger and separated from each other by scarcely a diameter, scarcely half as far from the laterals. Clypeus as high as one and one-half times the diameter of an anterior median eye. Second row of eyes wider than the first (28/16), narrower than the third eye row (28/34), separated by a diameter, farther from the posterior eyes (15/10). Eyes of the third row separated by about three diameters, smaller than those of the middle row (8/11).

Tibia and patella I, 2.00 mm. long

Tibia and patella IV, 2.83 mm. long.

Spines under the tibiae 2-2-0, the normal distal pair small or lacking.

TYPE LOCALITY.—Female holotype from Boulder Canyon, Colorado, July 22, 1908 (Lutz).

DISCUSSION.—This small species falls in the same group with *Pardosa distincta* (Blackwall), (synonym *pallida* Emerton, *emertoni* Chamberlin) and *Pardosa utahensis* Chamberlin (*sauviana* Chamberlin), both of which occur in Colorado, but the differences in the epigynum are clearly distinctive.

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DIAGNOSES OF NEW AMERICAN SPIDERS

By W. J. GERTSCH

In the course of arrangement of various families of spiders in the collection of The American Museum of Natural History, the following species new to science have been discovered. An agelenid from a cave in Indiana is regarded as representing a new generic type, the nearest American relatives of which are species of the genera *Cybaeus* and *Cybaeina*. Altogether, fourteen species are diagnosed as new, all the types of which are deposited in the collection of the American Museum.

Ebo pepinensis, new species

MALE.—Total length, 2.33 mm. Carapace, 1.03 mm long; 1.13 mm. wide; 0.46 mm in front. Abdomen, 1.33 mm. long; 1.06 mm wide.

Cephalothorax slightly broader than long, broadest just behind the third coxae, moderately high, rather abruptly constricted and truncated in front, provided with few hairs or spines. Integument of the carapace light brown, the sides irregularly marmorate in black, a dorsal band but slightly indicated above, the eye tubercles and the region of the indistinct cephalic sutures marked with white. Sternum, labium, endites, and legs yellow, rather thickly irrorate in brown. Abdomen gray to black, showing a faint basal maculation that runs back half the length of the dorsum, the venter paler.

First row of eyes recurved, the medians much larger (4/3), separated by a diameter, a third as far from the laterals. Second row of eyes broader (18/13), slightly recurved, the medians smaller, separated from each other by nearly twice their distance from the laterals. Posterior lateral eyes somewhat smaller than the anterior medians but larger than the anterior laterals. Median ocular quadrangle broader behind (10/9) but about as long as broad. Clypeus equal in height to a little more than the diameter of an anterior median eye.

Legs 21/13, usually unarmed but often with two pairs of spines beneath the tibiae.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.43	.60	1.23	1.06	.76	5.08 mm.
II	2.36	.83	2.26	1.93	1.26	8.64 mm.
III	1.30	.46	1.10	.83	.60	4.29 mm.
IV	1.46	.46	1.16	1.00	.60	4.68 mm.
Palp	.43	.23	.26		.30	1.22 mm.

MALE PALPUS.—Femur nearly equal to the length of the patella and tibia taken together, less than half the length of the carapace. The whole palpus a little longer than the carapace. Tarsus little expanded, much less so than in *Ebo latithorax* Keyserling, the tibial joint equal to it in length (considerably less in *latithorax*). Tibial apophysis short. Bulbous parts filling two-thirds or less of the tarsal length.

TYPE LOCALITY.—Male holotype, female allotype, and male and female paratypes from Wacouta Beach, Lake Pepin, Minnesota, May 15, 1932 (Gertsch, collector). These interesting little long-legged spiders were common on the sand at the water's edge and in the driftwood zones farther back, running freely about and apparently feeding on tiny flies. None of the females are mature.

Of the three species formerly placed in *Ebo*, only the genotype remains. A new generic name has been proposed for the group that includes *Ebo mexicana* Banks, while the generic affiliation of *Ebo oblongus* Simon is doubtful. *Ebo pepinensis*, new species, may be identical with spiders of this genus, found in the Great Basin region and on the Pacific Coast, but as there are only females in the collection, accurate determination is not possible at the present time.

***Micaria aurata* (Hentz)**

Figures 4 and 6

Herpyllus auratus HENTZ, 1847, Journal Boston Soc. Nat. Hist., V, p. 459, Pl. XXIV, fig. 15.

This brightly colored species is common throughout the region east of the Rocky Mountains. Females from Medicine Hat, Alberta, June, 1930 (Carr, collector), though differing somewhat in color, are in structural characteristics identical with the eastern form. The epigynum of a single female from City Creek, Salt Lake City, Utah, August 29, 1931 (Gertsch, collector), differs in minor details, as illustrated in figure 6, but in the absence of males it seems best to refer to it *aurata*.

***Micaria deserticola*, new species**

Figures 7 and 8

MALE.—Total length, 3.00 mm. Carapace, 1.33 mm. long; 0.80 mm. wide. Abdomen, 1.60 mm. long; 0.68 mm. wide.

Cephalothorax with a few long hairs on the clypeal margin and in the ocular region, the pars thoracica with very few iridescent silvery scales. Carapace almost uniform dark brown, with few darker streaks or contrasting markings. Sternum, labium, endites, and legs much lighter, the femora slightly darkened, provided with an even, though sparse, coating of hairs and devoid of heavy spines. Abdomen black, above apparently once covered with iridescent silvery scales, the venter lighter, the sides with remnants of a basal and a medial white band which do not extend to the dorsum. Spinnerets light.

Carapace weakly rounded on the sides, two-thirds as broad at the front as between the first and second coxae, the greatest cephalothoracic width, highest at the same point, the convexity moderate. Abdomen with the sides subparallel, constricted in the middle, little wider at the caudal end than medially, the spinnerets long and projecting.

Eye rows separated by about one and one-half diameters of a lateral eye. Eyes of the first row procurved, the medians larger and separated from each other by about two-thirds of a diameter, subcontiguous with the laterals. Eyes of the posterior row very slightly procurved, subequal, the medians little more than a diameter apart, less than that distance from the laterals. Median ocular quadrangle about as long as broad, the anterior medians larger. Clypeus as high as the diameter of an anterior median eye. Lower margin of the furrow of the chelicera armed with a single small tooth.

Palpus resembling that of *Micaria aurata* (Hentz), the proximal tibial margin with a heavy spur that is covered with hairs and weak spines, the bulb with a colorless appendage on the retrolateral margin, the embolus a short spine. Tibia about as long as broad. Other details as figured.

FEMALE.—Total length, 3.30 mm. Carapace, 1.30 mm. long; 0.80 mm. wide. Abdomen, 1.93 mm. long; 1.16 mm. wide.

Agreeing well with the male in general structure and color but with a submedian white transverse band on the abdomen. Epigynum as figured.

TYPE LOCALITY.—Male holotype and female allotype from Scottsdale, Arizona, December 24, 1902 (Britcher, collector).

The presence of a basal tibial spur rather than a distal one will separate this species from *Micaria coloradensis* and *perfecta*, which Banks described as coming from Colorado. It is quite different in color from *Micaria aurata* and has the tibial apophysis shorter and nearer the base of the joint than in that species.

Micaria utahna, new species

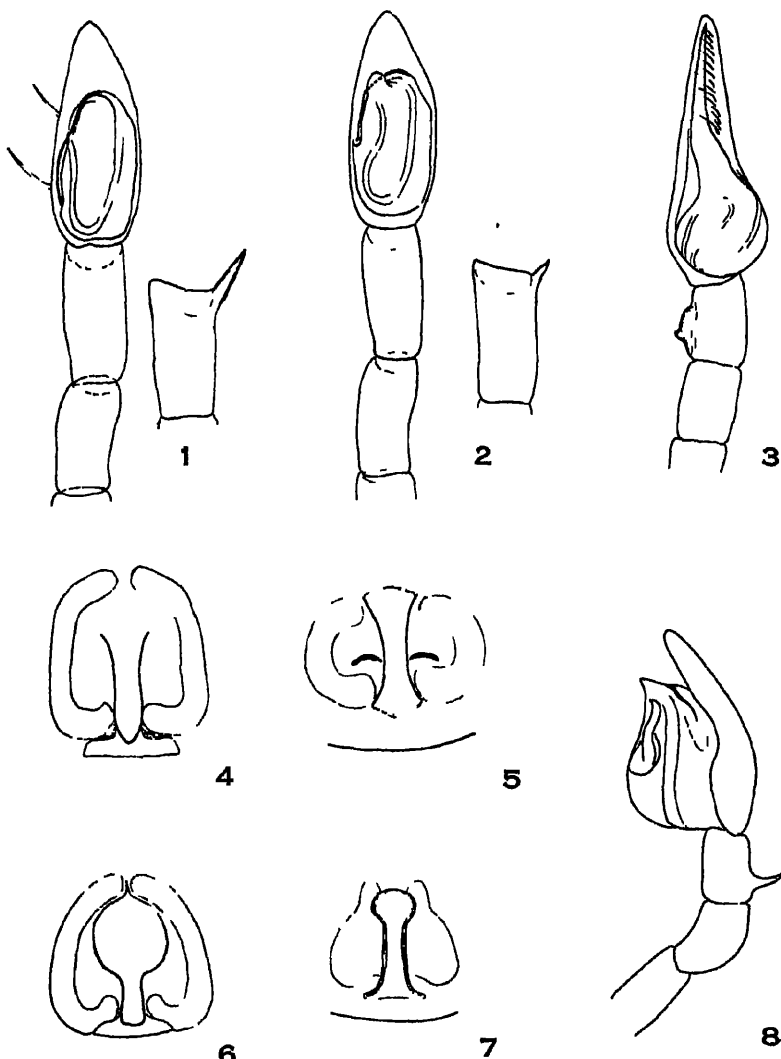
Figure 1

MALE.—Total length, 3.73 mm. Carapace, 1.53 mm. long; 1.03 mm. wide. Abdomen, 2.20 mm. long; 1.00 mm. wide.

Cephalothorax with a few weak spines on the clypeal margin and a sparse covering of iridescent silvery scales. Carapace uniform dark brown, somewhat streaked with black. Sternum, labium, endites, and basal leg joints lighter brown. Femora of legs darker, the distal joints light yellowish-brown. Legs with a sparse covering of hairs and a few stouter spines, especially on the last two pairs. Abdomen mostly black, with a few white scales, and with indistinct indications of transverse basal and submedian white bands, the venter lighter and clothed with iridescent light scales. Spinnerets dark.

Carapace two-thirds as wide at the front as at the widest point, between the second and third coxae, nearly equal in height throughout. Abdomen unconstricted, the sides weakly rounded, the spinnerets much shorter than in *Micaria deserticola*.

Eye rows about of equal width, the first procurved, the medians separated from each other by about two-thirds of a diameter, subcontiguous with the equal laterals. Posterior row of eyes slightly procurved, the medians scarcely a diameter from the equal laterals, about two diameters from each other. Side eyes about a diameter apart. Median ocular quadrangle about as broad as long, the eyes subequal. Clypeus equal in height to the diameter of an anterior median eye. Lower margin of the furrow of the chelicera with a single weak tooth.



- Fig. 1 *Micaria utahna*, new species, palpus.
 Fig. 2 *Micaria foxi*, new species, palpus.
 Fig. 3 *Castaneira nanella*, new species, palpus.
 Fig. 4 *Micaria aurata* (Hentz), epigynum.
 Fig. 5 *Micaria alkana*, new species, epigynum.
 Fig. 6 *Micaria cusata* (Hentz), variety, epigynum.
 Fig. 7 *Micaria deserticola*, new species, epigynum.
 Fig. 8 *Micaria deserticola*, new species, palpus.

Patella and tibia of the palpus together longer than the tarsus. Tibia twice as long as wide, with a distal retrolateral sharp spur that is nearly as long as the width of the joint. Tarsus twice as long as broad, the bulbal parts occupying two-thirds the length. Bulb without the hooklike appendage present in most of the species of the genus, the embolus very long, originating at the distal end and curving around the outer margin nearly to the base of the bulb.

TYPE LOCALITY.—Male holotype from City Creek Canyon, Salt Lake City, Utah, August, 1931 (Gertsch, collector)

This species differs from *Micaria coloradensis* Banks in having the metatarsi light, in the much longer embolus, and particularly in the absence of the hooklike appendage on the outer side of the bulb. It is more closely related to *Micaria foxi*, new species, from which it differs chiefly in having a much shorter tibial apophysis.

***Micaria foxi*, new species**

Figure 2

MALE. Total length, 3.00 mm. Carapace, 1.33 mm long; 0.90 mm wide. Abdomen, 1.66 mm. long; 0.80 mm. wide.

Carapace dark brown, with a few medial darker streaks, the eye margin darker and with a few black hairs. Sternum, labium, endites, and legs much lighter in color, the distal leg joints somewhat lightened. Legs sparsely clothed with hairs, and the tibiae of all the legs with weak spines beneath. Abdomen black above and thickly covered with iridescent purple scales, without a trace of transverse bands or spots of any kind, the venter as dark as the dorsum. Spinnerets black.

Carapace nearly equal in height throughout its length, about two-thirds as broad in front as between the third and fourth coxae. Abdomen with the sides subparallel, very weakly constricted at the middle, the spinnerets short.

Eyes of the first row procurved, subequal, the medians separated by scarcely two-thirds of a diameter from each other, nearly touching the laterals. Posterior row of eyes slightly procurved, the medians scarcely two diameters apart, less than a diameter from the equal laterals. Median ocular quadrangle scarcely as broad as long, as wide in front as behind, the anterior eyes slightly larger. Clypeus equal in height to the diameter of an anterior median eye. Lower margin of the furrow of the chelicera with a single small tooth.

Patella and tibia of the palpus together longer than the tarsus. Tibia twice as long as broad, provided with a very short, weak distal retrolateral spur not more than one-fourth the width of the joint. Tarsus twice as long as broad, the bulb of the palpus occupying two-thirds of the length. Bulb lacking the outer hooklike appendage, the embolus originating distally and curving around the outer margin for half the bulbal length, supported distally by a small lobate conductor.

TYPE LOCALITY.—Male holotype from Richfield, Utah, July 4, 1930 (D. F. Fox, collector)

This species or *Micaria utahna* may be the male of *Micaria formicoides* Chamberlin and Woodbury, but as the last name has already been used in this genus, it is unavailable as a specific name.

Micaria altana, new species

Figure 5

FEMALE.—Total length, 5.00 mm. Carapace, 1.93 mm. long; 1.20 mm. wide. Abdomen, 3.00 mm. long; 1.66 mm. wide.

Cephalothorax little more than half as wide at the front as at the widest point, between the second and third coxae, nearly equal in height throughout its length and only slightly sloping to the ocular area. Carapace very dark brown, provided with a few long hairs in the clypeal region and clothed with a few appressed hairs and lighter scales. Sternum, labium, and endites brown, with many long hairs. Legs lighter brown, lightened somewhat distally, the femora darker, all the members with appressed black hairs and a few lighter hairs and scales on the upper surface. All the legs with spines beneath the tibiae, three pairs beneath the two posterior pairs but only two pairs beneath the anteriors. Abdomen nearly twice as long as broad, weakly rounded on the sides, covered with iridescent black scales above except for the basal and median transverse white bands. Venter lighter except distally, with shiny scales, the spinnerets gray.

Anterior row of eyes slightly procurved, the medians separated by a diameter, slightly larger and subcontiguous with the laterals. Posterior row of eyes slightly procurved, the medians about two diameters apart and scarcely a diameter from the larger laterals. Median ocular quadrangle slightly longer than broad, not narrower in front, the anterior medians slightly larger. Clypeus equal in height to one and one-half times the diameter of an anterior lateral eye. Lower margin of the furrow of the chelicera with a single small tooth.

Epigynum as figured.

TYPE LOCALITY.—Female holotype from Seba, Alberta, July, 1930. Female paratypes from Bloomington, Idaho, August 19, 1931 (Gertsch, collector).

Castaneira nanella, new species

Figure 3

MALE.—Total length, 4.69 mm. Carapace, 1.76 mm. long; 1.06 mm. wide. Abdomen, 2.93 mm. long; 1.10 mm. wide.

Carapace dark yellowish-brown, medially a little lighter. Sternum, labium, and endites light brown, dark-margined. Femur of first leg dark brown except distally, the other joints yellow. Femora of the other legs with lateral brown bands, the third and fourth metatarsi also with side streaks, otherwise yellow. Palpus with brown side bands. Abdomen black, basally with four transverse orange-brown broken streaks, the last much reduced. Venter of abdomen light brown, laterally with a black and a white bar, caudally black.

Carapace much longer than broad, the pedicel joining the abdomen clearly distinct from above and roughened as in antlike spiders. Abdomen narrow basally, gradually widened to a point near the posterior end and then rounded caudally.

Eyes of the first row slightly procurved, the medians a little smaller, separated by scarcely two-thirds of a diameter, almost touching the laterals. Posterior eyes subequal in size, slightly procurved, the medians separated by a diameter, half as far from the laterals. Median ocular quadrangle as long as broad, somewhat narrowed

in front, the posterior eyes larger, about equal to the anterior laterals. Clypeus about as high as the diameter of an anterior median eye. Lower margin of the furrow of the chelicera with two small teeth, the upper also with two, one of which is larger.

The first tibia with 1-2-2 spines beneath, no distals present.

TYPE LOCALITY.—Male holotype from City Creek Canyon, Salt Lake City, Utah, August, 1931 (Gertsch, collector)

In many respects this species is intermediate in generic position between *Castaneira* and *Mazax*. In the latter genus the pedicel is very conspicuous, distinctly rugose, and more or less intimately jointed to a large oval, chitinous dorsal sclerite, which is often armed with heavy spines and overhangs the base of the abdomen. The posterior eyes are practically straight and on the average are somewhat larger than in *Castaneira*. The pedicel in *C. nanella* differs only in degree from that of species of *Mazax*, and the abdominal armature is completely lacking, but there is distinct agreement in the eye arrangement, in the teeth on the furrows of the chelicerae, and in other points. I place it in *Castaneira* mainly on the basis of the palpus, which is obviously close to other species in the genus. As this new form is described from a single male it is at present impossible to connect it with *Castaneira lineata* Emerton, which comes from Massachusetts and was described from a female.

Clubiona texana, new species

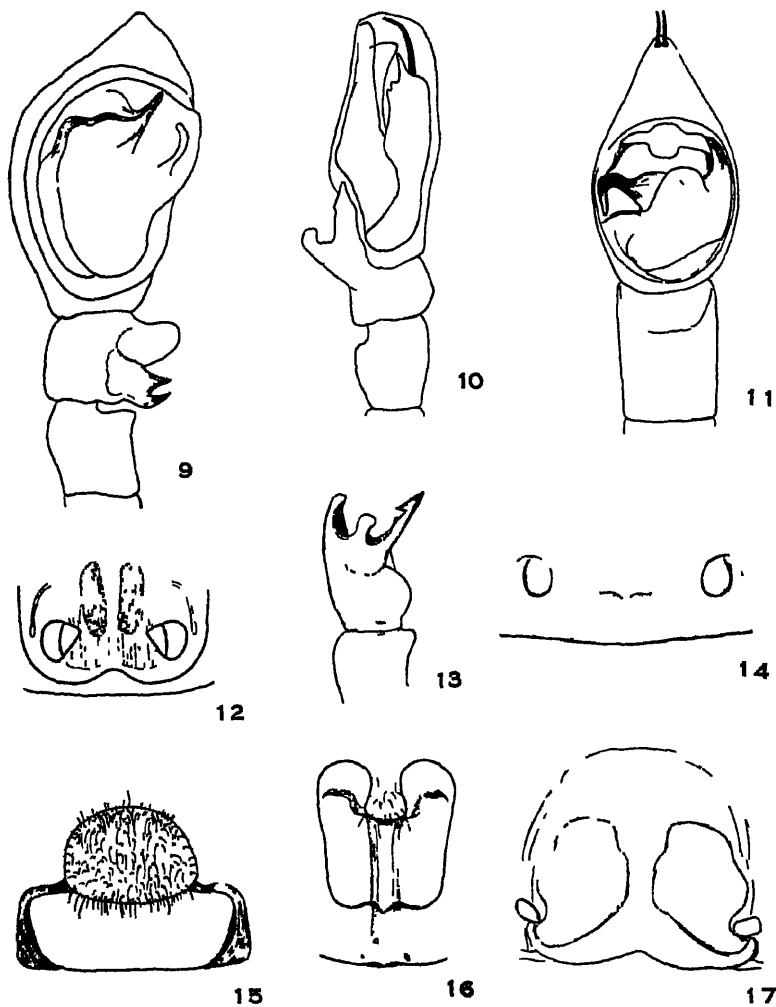
Figure 16

FEMALE—Total length, 11.66 mm. Carapace, 3.86 mm long; 2.63 mm wide. Abdomen, 7.80 mm long; 4.00 mm. wide

Cephalothorax nearly three-fourths as wide at the front as at the widest and highest point, between the second and third coxae, the sides weakly rounded, provided with a sparse covering of black hairs. Carapace light brown. Sternum light brown, the labium and endites somewhat darker. Legs concolorous with the carapace basally but, because of the thick clothing of hairs on the distal joints, appearing darker there. Abdomen gray basally, with darker chevrons near the spinnerets, the venter pale.

Eyes of the first row straight, subequal in size, equidistantly spaced one-third of a diameter apart. Posterior row of eyes slightly procurved, the medians slightly farther apart than their distance from the equal laterals. Median ocular quadrangle broader than long (20/17), narrower in front by the same ratio, the anterior medians larger in size. Clypeus very narrow, about one-third as wide as the diameter of an anterior median eye. Lower margin of the furrow of the chelicerae with four teeth, of which the two middle ones are larger, the upper margin with five, one larger than the others.

Tibiae of legs I, II, and IV with a basal and median pair of long spines beneath, tibia III with single basal, median and distal spines beneath. The first two metatarsi with a single pair of basal spines, the last two with 2-2-2 spines beneath.



- Fig. 9. *Agelena lutsi*, new species, palpus.
 Fig. 10. *Clubiona intermontana*, new species, palpus
 Fig. 11. *Allocosa noctuabunda* Montgomery, Palpus
 Fig. 12. *Anyphaena schwarzi*, new species, epigynum.
 Fig. 13. *Clubiona intermontana*, new species, tibia of palpus
 Fig. 14. *Anyphaenella immaculella*, new species, epigynum
 Fig. 15. *Auchicybaeus ovalis*, new species, epigynum.
 Fig. 16. *Clubiona texana*, new species, epigynum.
 Fig. 17. *Arctosa imperiosa*, new species, epigynum.

TYPE LOCALITY.—Female holotype from Brownsville, Texas, January 3–11, 1928 (Lutz, collector).

This large species is more closely related to species described from Mexico than any found within the United States. The details of the epigynum are sufficient to separate it from the *Clubionas* named by the Cambridges, of which species it more closely approximates *sericea*.

***Clubiona intermontana*, new species**

Figures 10 and 13

MALE.—Total length, 4.40 mm. Carapace, 2.03 mm long; 1.53 mm. wide. Abdomen, 2.46 mm long; 1.33 mm. wide.

Cephalothorax with a sparse clothing of short, appressed, black hairs. Carapace light yellowish-brown, unmarked, the eyes ringed in black. Sternum and labium margined indistinctly in black, otherwise equivalent to the carapace. Legs concolorous with the carapace, the metatarsi and tarsi thickly scopulate beneath, the spines on the members conspicuous. Abdomen brown above, with numerous small, lighter spots provided at the pedicel with long black hairs. Spinnerets light yellowish-brown.

Legs 4213, the anterior tibiae with a basal and submedian pair of spines, the metatarsi with a single basal pair.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.66	.83	1.50	1.10	.73	5.82 mm.
II	1.66	.83	1.56	1.10	.73	5.88 mm.
III	1.50	.66	1.13	1.26	.53	5.08 mm.
IV	2.00	.80	1.66	2.06	.66	7.18 mm.

The first row of eyes practically straight, narrower than the second, the medians somewhat smaller and separated from each other by about one-third their diameter, even nearer to the laterals. Second row of eyes very slightly recurved, the medians about equal in size to the laterals and subequidistantly spaced, a little over a diameter apart. Median ocular quadrangle broader than long (16/12), much narrower in front, the eyes about equal. Clypeus about one-third as high as the diameter of an anterior median eye. Lower margin of the furrow of the chelicera with two small teeth beneath.

TYPE LOCALITY.—Male holotype from Slough Creek, Yellowstone National Park, Wyoming, August, 1931 (W. E. Gertsch, collector).

This species can scarcely be confused with any other described from the United States. The palpus is suggestive of *Clubiona canadensis* but differs in the proportions of the tibial apophysis and in the details of the bulb. Viewed laterally, the tibia presents three well-defined retrolateral lobes, the middle one of which is much shorter or completely lacking in *canadensis*.

***Anyphaenella immaculella*, new species**

Figure 14

FEMALE.—Total length, 3.83 mm. Carapace, 1.53 mm long; 1.13 mm. wide. Abdomen, 2.40 mm. long; 1.53 mm. wide.

Cephalothorax and abdomen completely devoid of hairs or spines of any kind. Carapace immaculate, light yellow in color, the eyes ringed in black. Sternum with an indistinct scalloped black marginal band, light yellow. Labium, endites, coxae, and legs concolorous with the carapace, also immaculate, the legs distally scopulate. Abdomen whiter than the carapace, without markings of any kind.

Legs 1423, very slender, provided with long spines, with first two tibiae and metatarsi with a basal and median pair.

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	2 16	73	2 93	3 03	1 33	10.18 mm.
II	1 50	50	1 56	1 50	56	5 62 mm.
III	1 16	43	93	1 20	36	4.08 mm.
IV	1 93	53	1 80	1 83	50	6.59 mm.

First row of eyes narrower than the second, straight, the medians much smaller, scarcely two-thirds of a diameter apart and about half as far from the laterals. Second row of eyes procurved, the eyes subequal, the medians nearly two diameters apart (3/5), scarcely more than a diameter from the laterals. Median ocular quadrangle much narrower in front, very slightly broader (11/10) than long, the posterior median eyes much larger, little larger than the anterior laterals. Clypeus equal in height to the diameter of an anterior median eye. Chelicerae with five small teeth on the lower margin.

TYPE LOCALITY.—Female holotype and female paratype from Sabino Basin, Santa Catalina Mountains, Arizona, July 8–12, 1916 (Lutz, collector).

Only two other species of spiders definitely known to belong to this genus are found in the United States, and neither of these has so far been found west of the Rocky Mountains. *Anyphaenella immaculella* is closely related to *A. saltabunda* (Hentz), agreeing structurally in all details except in the comparative leg lengths and in epigynal characters. In *immaculella* the first metatarsus is twice as long as the carapace (1.53/3.03), while in the other species it is much shorter (1.66/2.33). Both agree in having the first tibia approximately equal to the metatarsus, by which character they may be separated from *A. alba* (Hentz).

Anyphaena schwarzi, new species

Figure 12

FEMALE.—Total length, 4.10 mm. Carapace, 1.73 mm long; 1.33 mm. wide. Abdomen, 2.33 mm long; 1.33 mm. wide.

Cephalothorax about five-eighths as broad in front as at the widest and highest point, a line between the opposite third and fourth coxae, the sides weakly rounded. Carapace sparsely covered with short white hairs, the sides infuscated, leaving a broad median longitudinal light brown area. Sternum, labium, and endites light. Femora of legs infuscated, the distal joints light yellowish-brown in color, clothed with long black hairs and spines. Abdomen light gray, thickly and evenly marked and reticulated with black, the venter paler. Spinnerets light. Ventral furrow slightly nearer the genital furrow than the spinnerets.

Eyes of the first row straight, the medians separated by scarcely two-thirds of their diameter, nearly contiguous with the larger laterals. Second row of eyes straight, the medians separated a little more than their diameter, over half as far from the subequal laterals. Median ocular quadrangle slightly broader than long (13/11), narrowed in front, the posterior median eyes larger than the anteriors, slightly larger than the anterior laterals. Clypeus about two-thirds the diameter of an anterior median eye.

Legs furnished with conspicuous long spines, the first two tibiae with a basal and median pair, the third and fourth with three pairs, the last apical. The first metatarsi with a single basal spine, in this respect differing from all other *Anypheanas* in the United States, the second with a basal pair. All femora with three long spines on the dorsal surface.

Epigynum resembling that of *Anypheana laticeps* Bryant, but differing in the degree of separation of the openings, in their shape, and in the internal epigynal details.

TYPE LOCALITY.—Female holotype from Brownsville, Texas, January 3–11, 1928 (Schwarz, collector).

AUCHICYBAEUS, new genus

A genus of the agelenid subfamily Cybaeinae related to *Cybaeus*.

Carapace longer than wide (26/21), over half as broad in front as the greatest width (6/11), moderately high throughout, the median cephalothoracic suture a deeply impressed pit, the sutures defining the pars cephalica distinct but not very deep. Labium a little broader than long, scarcely half as high as the subparallel, robust endites. Chelicerae provided on the upper margin with three subequal separated teeth, the lower margin with four more closely approximated to each other. Eyes subequal, the first row recurved and the medians a little nearer each other than the laterals, the posterior row very slightly recurved, the medians somewhat nearer each other than the laterals. Clypeus scarcely as wide as the diameter of an anterior median eye. Abdomen oval, somewhat produced in front and slightly overlapping the carapace. Spinnerets subapical, approximated, the anteriors slightly separated, a distinct colulus between them, the last pair very short and apparently one-jointed. Legs 1243, the tibiae of the first pair with 2–2–1–1 spines beneath, an apical not present.

GENOTYPE — *Auchicybaeus ovalis*, new species.

In *Cybaeus* the length of the femur never equals that of the carapace, but in this new genus the joint is half again as long. The large elevated abdomen of *Auchicybaeus* conspicuously overhangs the carapace as in many theridiids.

***Auchicybaeus ovalis*, new species**

Figure 15

FEMALE — Total length, 11.50 mm. Carapace, 4.90 mm. long; 4.00 mm. wide. Abdomen, 7.30 mm. long; 5.00 mm. wide.

Cephalothorax practically bare, provided with only a few inconspicuous fine black hairs. Carapace mostly dull yellow, the margins of the pars thoracica touched with black, the cephalothoracic striae shadowed in brown. Eye tubercles blackened. Sternum, labium, and endites brown, clothed sparsely with long black hairs. Legs yellow, evenly and rather thickly covered with long black hairs and numerous long spines on the basal joints, the metatarsi and tarsi heavily and evenly spinose, the patellae with broad distal brown rings, the tibiae with broad submedian and distal annulae. Abdomen very high basally, rather thickly clothed with black hairs, the integument dull yellow in color, basally with large gray lateral maculations followed by indistinct smaller gray chevrons that completely cover the caudal portion, the pattern and color very much resembling that of the species of *Cybaeus* and *Amaurobius*. Venter lighter, gray in front of the light brown spinnerets which are whitened distally.

First row of eyes very slightly narrower than the second row, rather strongly recurved, the laterals a little larger, the medians about half a diameter apart, two-thirds of a diameter from the laterals. Second row of eyes very slightly recurved, the eyes subequal, the medians half a diameter apart, about a diameter from the laterals. Median ocular quadrangle as broad as long, very slightly narrower in front. Clypeus about equal to the height of an anterior median eye.

Legs 1243, the anterior tibiae with 2-2-1-1 spines beneath

	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	7 70	2 45	7 70	7 98	2 94	28.77 mm.
II	7 00	2 10	6 09	6 02	2 45	23.66 mm.
III	5 32	1 40	3 50	4 48	1 82	16.52 mm.
IV	7 00	1 89	5 04	5 74	1 82	21.49 mm.

Epigynum a broad transverse rectangular plate, in front of which is a large tubercle

TYPE LOCALITY.—Female holotype from Marengo Spring Cave, Crawford County, Indiana, October 20, 1911, taken in the "area of total darkness" by Arthur W. Henn.

It is quite improbable that this species is the same as Banks' *Tegenaria cavicola*, which was found in caves in Indiana and described from immature specimens. The eye relations and the short spinnerets are characters of such importance that it seems unlikely that Banks could have confused this species with the genus *Tegenaria*. A species of *Coras*, recently described from the southern states by Crosby and Bishop as a *Coelotes* (*C. plumarius*), could likewise scarcely belong here, although the epigynal structure is very similar.

Agelena lutzii, new species

Figure 9

MALE.—Total length, 5.66 mm. Carapace, 2.93 mm. long; 2.33 mm. wide. Abdomen, 2.66 mm. long; 2.00 mm. wide.

The spider on which this name is based has been dried, with the result that the carapace is somewhat distorted. The tarapace was provided with the median and

lateral longitudinal light bands as in other species of the genus, though in this specimen they are indistinct, the intervals between the bands being dark, a covering of appressed gray hair clothing the cephalothorax. Legs quite thickly provided with suberect hairs and longer spines, yellow in color, the femora with black annulae basally, medially, and distally. Sternum, labium, endites, and coxae light brown. Abdomen thickly covered with long black hairs and spines above, the venter gray, basally lighter. Last spinnerets half again as long as the first pair.

Anterior row of eyes procurved, subequal, the medians about a radius apart, one-third of a diameter from the laterals. Posterior row of eyes procurved, subequal, the medians two-thirds of a diameter apart, nearly as far from the laterals. Median ocular quadrangle slightly longer than broad, somewhat narrower in front. Clypeus equal to the diameter of an anterior lateral eye.

Chelocerae with two subequal teeth on the lower margin, the upper with four denticles, three of which are very small. Tibia I, II, and III with 2-2-2 spines beneath, IV with 1-1-2.

Tibia and patella of the palpus about equal to the femur in length. Tibia broader than long, provided with three processes, a ventral distal sharp spur half as long as the joint that rests on the cymbial margin, and two retrolateral chitinous projections, the anterior a rounded spur, the posterior distinctly notched. Embolus of bulb a fine tube, the apical portion resting as a sharp, simple, ventrally-directed conductor, laterad of which is a colorless bulbal lobe. The figure is sufficient to separate this species from the numerous western forms.

TYPE LOCALITY.—Male holotype from Mesa Verde Park, Colorado, taken July 3-7, 1919, on Chapin Mesa at an altitude of 6900-7700 feet by Dr. F. E. Lutz, for whom the species is named.

Arctosa imperiosa, new species

Figure 17

FEMALE.—Total length, 11.30 mm. Carapace, 5.00 mm. long; 3.71 mm wide. Abdomen, 6.00 mm long; 3.71 mm wide.

Cephalothorax with a sparse covering of fine black hairs, the region of the eyes provided with a few black spines. Carapace bright ochraceous orange to dark brown, a median light band beginning at the eye group, strongly expanded behind, and then narrowed irregularly caudally to the width of the third eye row. Sides with a marginal light band abruptly ended at the first coxa, the remainder dark brown. Legs uniform in color, light orange-yellow, sparsely clothed with fine black hairs. Sternum and endites concolorous with the legs, the labium black. Dorsum of abdomen dark brown, basally with a bright hastate median maculation that runs half the length of the abdomen, the sides with irregular light spots.

First row of eyes straight, much broader than the second (39/29), the medians larger and separated by a radius, scarcely as far from the laterals. Eyes of the second row larger than the others, separated by two-thirds of a diameter, much narrower than the posterior eyes (29/33). Last row of eyes practically four diameters apart, the eyes equal to the anterior medians, scarcely one and one-half diameters from the corresponding eyes of the second row. Dorsal eye quadrangle much broader than long (36/20), greatly narrowed in front. Clypeus about as high as the diameter of an anterior median eye. Lower margin of the furrow of the chelicera with three teeth.

Legs all very stout, clothed with black hairs and heavy spines, all metatarsi with three pairs beneath, tibia I, 0-2-2, tibia II, 1P-1P-2, tibia III, 2-1R-2, and tibia IV, 2-2-2 beneath, the first two tibiae lacking spines above but with a single submedian short robust spine on the last two pairs above.

Tibia and patella I, 4.20 mm long.

Tibia and patella IV, 4.40 mm long.

Epigynum as figured

TYPE LOCALITY.—Female holotype and female and immature paratypes from Colorado Springs, Colorado, July 20, 1908. An immature female of this species apparently comes from Pikes Peak, Colorado, 10,000 feet altitude (Cockerell).

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AN ANCESTRAL CROCODILE

BY BARNUM BROWN

Pending the publication of detailed studies now in course of preparation, the following preliminary notice gives the essential characters that distinguish a new family of reptiles:

The characters taken from a fairly complete skeleton qualify this form to be in the line of ancestry of the crocodiles.

The specimen was collected by the author fifteen miles northeast of Cameron, Arizona, during 1931, in the highly colored red beds that have been described by Gregory¹ as a part of the Chinle.

This particular horizon I am designating in a later discussion as near the base of the Upper Triassic, as I am of the opinion the Triassic in Arizona is of tripartite division.

ARCHAOSUCHIDAE, new family

FAMILY CHARACTER.—Pubis forming part of acetabulum, but nearly excluded. *Archaeosuchus richardsoni* = new genus and species.

TYPE.—A. M. N. H. No. 3024. An articulated skeleton nearly complete

HORIZON.—Base of Upper Triassic.

LOCALITY.—Fifteen miles northeast of Cameron, Arizona.

GENERIC AND SPECIFIC CHARACTERS.—Body of medium size with dermal and ventral armor; dorsal scutes in two median rows covering vertebrae and upper ends of ribs. Ventral scutes in several rows. Tail completely armored. Head short, with medium-sized supratemporal fenestra. Orbits large, laterally placed. Nose pointed. Teeth sub-conical, in sockets. Palate bridged anteriorly. Vertebrae amphiplatyan; two vertebrae in sacrum. Ribs double-headed, posterior dorsal ribs articulating with transverse processes. Pectoral girdle with coracoid elongate and pierced. Clavicles cartilaginous, interclavicle long, rod-like. Limbs typically crocodilian. Carpals reduced to two long bones. Fifth digit of pes rudimentary.

¹Gregory, H. E. 1917 'Geology of the Navajo Country' U. S. Geol. Survey, Prof. Paper 93.



Fig. 1.—*Archaeosuchus richardsoni* (A. M. N. H. No. 3024). Dorsal view of skeleton in original matrix One-fourth natural size.



Fig. 2—*Archaeosauichus richardsoni* (A. M. N. H. No. 3024). Ventral view of skeleton in original matrix. One-fourth natural size

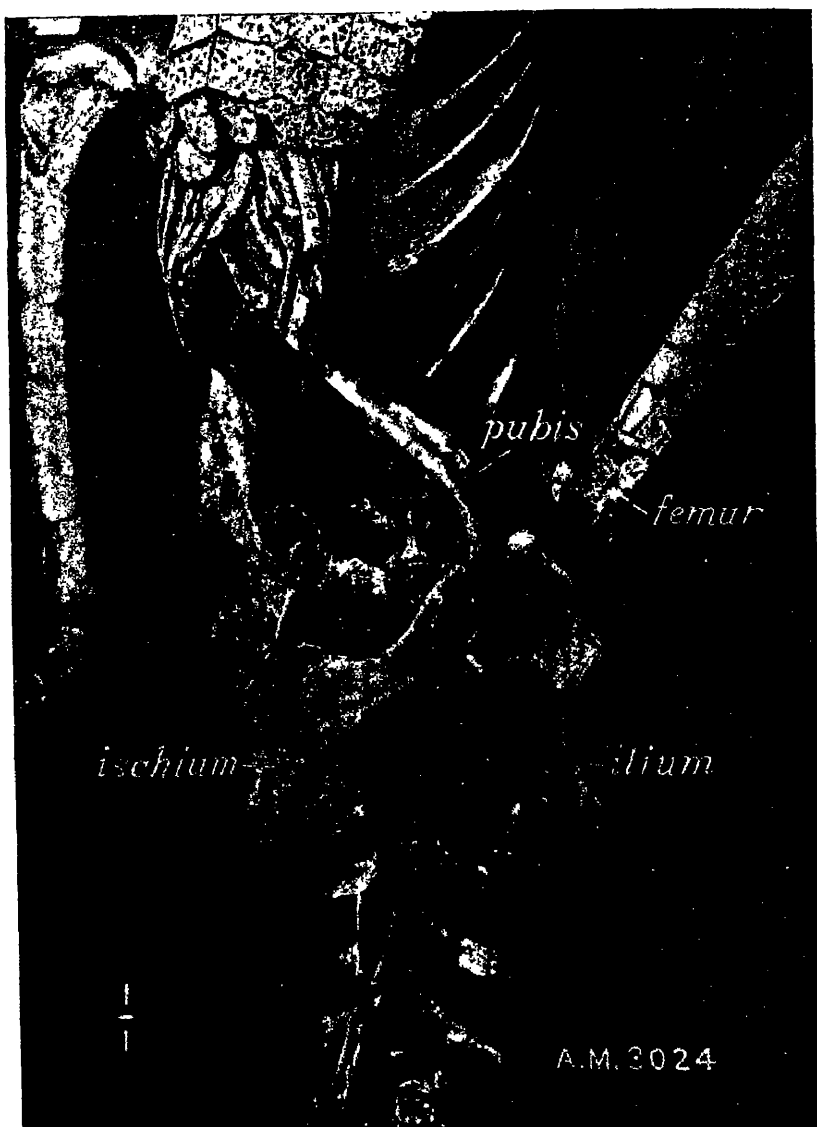


Fig. 3.—*Archaeosuchus richardsoni* (A. M. N. H. No. 3024). Proximal end of femur removed to show articulation of ilium, pubis, and ischium. Natural size.

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SERBELODON BURNHAMI, A NEW SHOVEL-TUSKER FROM CALIFORNIA

BY HENRY FAIRFIELD OSBORN

The discovery of a new shovel-tusker, distinct from *Amebelodon* and *Platybelodon*, is among the great surprises of the recent explorations by Mr. Childs Frick. He has kindly asked me to describe this novelty

Serbelodon burnhami, sp. nov., type mandible, F: A. M. 18228, discovered by Mr. John C. Blick, Ricardo, California, February, 1933, "just above the last basalt flow some miles northeast of Ricardo post office and apparently in or near the base of the Ricardo. . . . Fragments to date [April 12, 1933] evidence an associated fauna that includes a moderate sized horse (?*Pliohippus*), a large and a small sized camel, and an antelope (?*Merycodus*). . . Two superior tusk fragments [were] received with the symphysis—a much aged and worn distal fragment, F: A. M. 18228A, and a distal section of a smaller tusk, F: A. M. 18228B."

The type consists of the anterior portion of the mandible with two broad flattened incisive teeth and, as compared with *Platybelodon grangeri*, relatively narrow rostrum. It is also apparently distinguished by the absence of the dentinal tubules characteristic both of *Platybelodon grangeri* and of *Amebelodon fricki*. The shape of the rostrum suggests comparison with that of *Serbelodon barbourensis* (F: A. M. 25730) found in the lower Pliocene of Ainsworth, Nebraska. The size of *Serbelodon barbourensis* of the lower Pliocene is similar to that of *Serridentinus serridens*, but the size of *Serbelodon burnhami* of the upper Pliocene will probably be found to equal that of *Platybelodon grangeri*. Not only in size but in the evolution of the shovel tusks, *Serbelodon burnhami* is far more primitive than *Serbelodon barbourensis*.

Comparative measurements of *Platybelodon grangeri*, *Serbelodon barbourensis* and *Serbelodon burnhami* are as follows:

	<i>Platybelodon grangeri</i> (A. M. 26468)	<i>Serbelodon burnhami</i> (F: A M 18228)	<i>Serbelodon barbourensis</i> (F: A M. 25730)
Condyle to extremity of symphysis	1300		910 mm.
Length of incisors	510	610	380
Terminal width of incisors	163	133	77
Combined width of incisors at emergence from ramus	342	313	177
Maximum thickness of tusk	32	47	45
Length of symphysis	640	630e	305
Width of ramus across narrowest part	151	296	178

The incisors of the *Serbelodon burnhami* type resemble those of the *Serbelodon barbourensis* type in evidence of superior wearing abrasion of the proboscis and of lateral and interior rounding action, leaving them gently rounded or convex as viewed from in front, whereas in *Platybelodon grangeri* there is less evidence of superior abrasion by the proboscis than of strong evidence of the sharp chisel-shaped edge being produced by wear on flattened stones, this being characteristic of all the incisive teeth in the large American Museum collection from the Tung Gur beds of the Gobi Desert representing all stages of growth. Secondly, in *Serbelodon* the upper face of the incisors is transversely concave and upcurved on the outer border while that of *Platybelodon* is relatively plain. Thirdly, there is no trace of dentinal tubules in *Serbelodon*, the interior of the tusks being pure dentine.

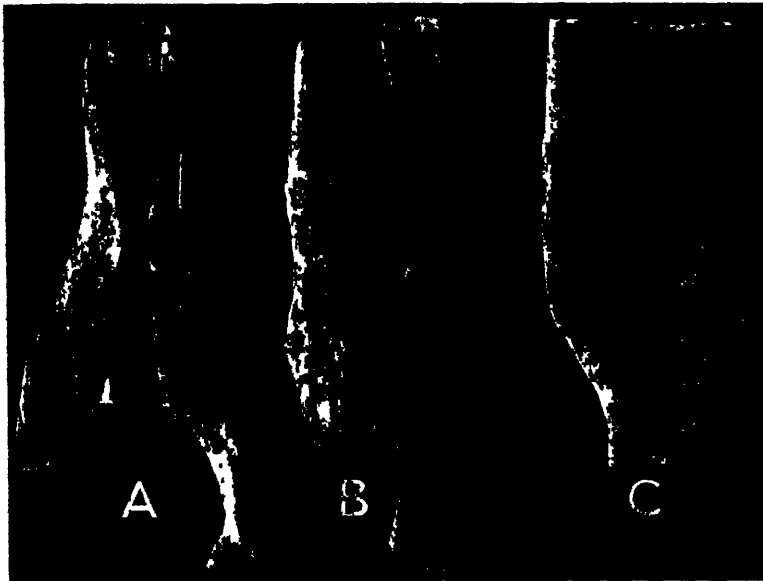
The symphysis of *Serbelodon burnhami*, while badly fractured, broadly resembles that of *Serbelodon barbourensis* in lacking the pronounced broadening of the rostrum characteristic of *Platybelodon grangeri*, the sides converging gradually into the sharp superior border and relatively stout section of the ramus even at its narrowest point in contrast to the extremely compressed ramus of *Platybelodon*. While the *Serbelodon burnhami* jaw is nearly double the size of that of *Serbelodon barbourensis*, it nevertheless exhibits numerous similar generic characters although very clearly separated as to species. We take great pleasure in naming this new species after Mr. Frederick Burnham,

brother-in-law of Mr. Blick to whom American palaeontology is so greatly indebted for his very successful explorations in the Pliocene fauna of North America.

GENERIC CHARACTERS OF SERBELODON

The type of *Serbelodon burnhami* enables us to expand the generic description of *Serbelodon* by Mr. Childs Frick,¹ as follows:

Serbelodon: (1) Mandibular symphysis heavy and short, inferior incisors of shovel-tusk adaptation broadened, analogous to those of



SERBELODON, AMEBELODON, PLATYBELODON, SHOVEL-TUSKS COMPARED

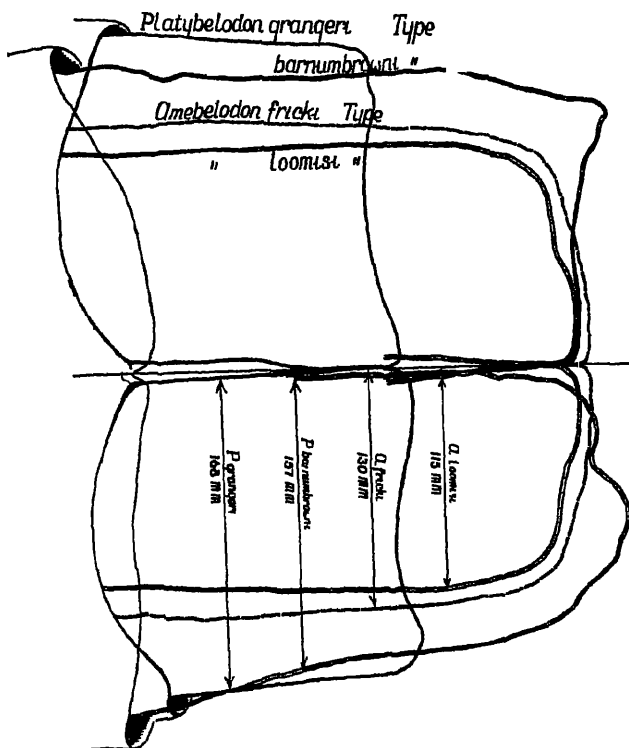
Fig 1. (A) Type mandible of *Serbelodon barbourensis* Frick (F: A. M. 25730); (B) Type rostrum of *Serbelodon burnhami* Osborn (F: A. M. 18228); (C) Rostrum of *Platybelodon grangeri* ref (A. M. 26468). All to the same scale of about $\frac{1}{12}$ natural size.

Platybelodon but distinguished by absence of dentinal tubules; (2) mandibular rostrum relatively broad, without the posterior constriction of the symphysis characteristic of *Platybelodon*; (3) shovel-shaped incisors with rounded lateral and inferior extremities as in *Amebelodon*, in contrast to chisel-shaped extremities of *Platybelodon*; (4) grinding teeth of

¹Frick, Childs 1933 'New Remains of Trilophodont-Tetrabelodont Mastodons.' Bull. Amer. Mus. Nat. Hist., LIX, Art. IX, pp. 592, 594 et seq.

primitive serridentine pattern unlike those of *Amebelodon*; (5) shovel-tusk adaptation progressive from *Serbelodon barbourensis* (lower Pliocene), an animal of medium size, to that of *Serbelodon burnhami* (upper Pliocene), of very large size.

The superposed outlines (Fig. 2) of the shovel-tusks emerging from the rostrum display the marked differences between the broad and relatively short tusks of *Platybelodon grangeri* and *Platybelodon barnumbrowni* and the elongate and relatively narrow incisive tusks of *Amebelodon*



PLATYBELODON AND AMEBELODON, SHOVEL-TUSKS SUPERPOSED

Fig. 2. Incisive tusks of the typical shovel-tuskers with dentinal tubules. *Platybelodon grangeri* type (A. M. 26200) of the Tung Gur horizon, Gobi Desert. *Platybelodon barnumbrowni* Barbour, type (Neb. Mus. 1-10-7-31) of Nebraska. *Amebelodon fricki* Barbour, type (Neb. Mus. 4-4-27) of Freedom, Frontier County, Nebraska. *Amebelodon* (*Torynobelodon*) *loomisi* Barbour, type (Neb. Mus. 2-3-9-28), near Republican City, Harlan County, Nebraska. About $\frac{1}{4}$ natural size.

fricki and *Amebelodon* (*Torynobelodon*) *loomisi* which closely resemble each other; whereas *Platybelodon grangeri* with its chisel-edged incisors differs from *Platybelodon barnumbrowni* with its irregular anterior incisive border. All these tusks differ from those of *Serbelodon* in the presence of dentinal tubules which are absent in *Serbelodon*.

NEW GENERIC CHARACTERS OF PLATYBELODON

Platybelodon: (1) Fourth superior and inferior premolars with four ridge-crests instead of three ridge-crests as in *Amebelodon* and *Serbelodon*. (2) Strongly developed serridentine molar pattern broadly resembling that of *Serridentinus floridanus* and demonstrating clear sub-family distinction from *Amebelodon* in which the superior and inferior molars are of the *Trilophodon* pattern. (3) It now appears that *Platybelodon* is an offshoot of the Serridentinae rather than of the Amebelodontinae as originally supposed.

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A NEW GENUS OF STEGOCEPHALIA FROM THE TRIASSIC OF ARIZONA

BY BARNUM BROWN

Recently the American Museum received by gift from Mr. Henry Bird a specimen that is of unusual interest as it represents a group of the Stegocephalia not heretofore known to occur in America. Its discovery throws additional light on the age of the Triassic strata of Arizona, which will be discussed in a succeeding paper.

This specimen is a natural mold of the palate and an impression of a part of the inside of the pterygoid region of the skull not connected. No bone is present, but the impressions are so perfect and faithful in detail that casts of the bones have been made permitting an accurate description.

It was found by Mr. R. T. Bird while on a motorcycle trip through Arizona, and it gives me great pleasure to name the species for him. The following record accompanied the specimen: "Picked up six and six-tenths miles southwest of Winslow, Arizona, near the road to Pine and Payson along the edge of a small mesa with other fossil remains. Triassic sandstone, November 9, 1932."

The other fossil remains referred to that I have seen are unidentifiable plant impressions.

Stanocephalosaurus birdi, new genus and species

TYPE OF GENUS AND SPECIES.—A. M. N. H. No. 3029. Impressions of a palate and the internal pterygoid region of skull.

LOCALITY.—Six and six-tenths miles southwest of Winslow, Arizona.

HORIZON.—Middle Triassic.

GENERIC AND SPECIFIC CHARACTERS.—Skull much longer than broad, triangular, with obtuse rounded snout. Parasphenoid very slender. Internal nares narrow, elongate and in line with vomerine and palatine tusks. A transverse row of small teeth between the vomer tusks and another row along the inner border of the internal nares.

A complete skull will probably disclose characters of distinct family rank which may be characterized by this genus, but I hesitate to designate a family without defining it more clearly than can be done with an impression.

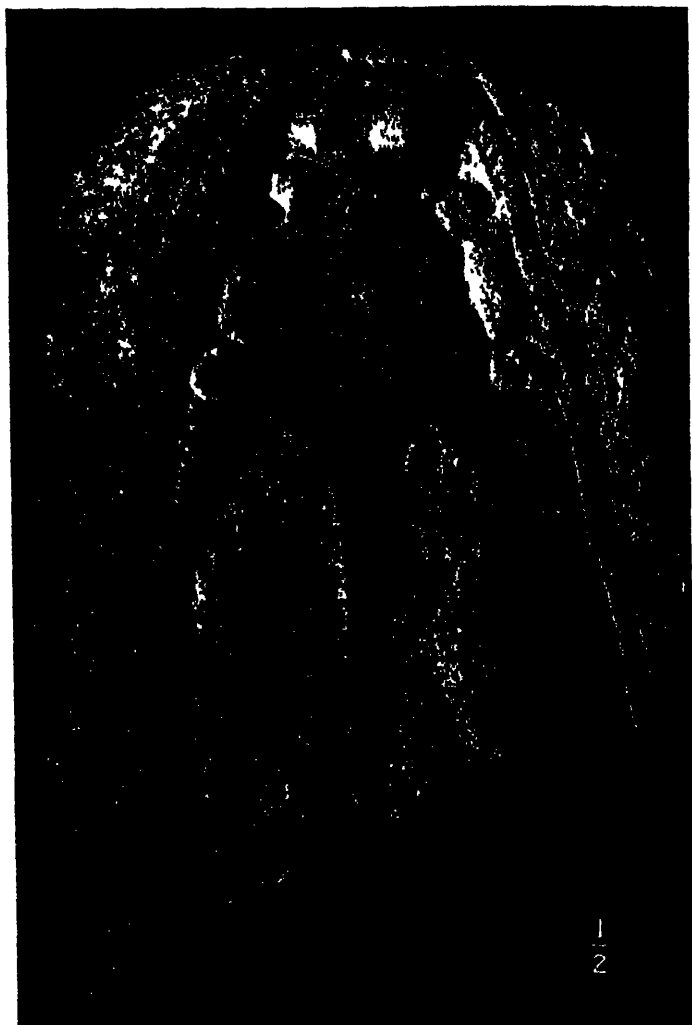


Fig 1.—*Stanocephalosaurus birdi* (A. M. N. H. No. 3029): Natural impression of palate. Ventral view. One-half natural size.



Fig. 2—*Stanocephalosaurus birds* (A. M. N. H. No. 3029). Cast of palate taken from natural impression. One-half natural size.

The palate as a whole establishes the relationship of this genus among the Stereospondylous Stegocephalia, and its nearest relatives are apparently among the Capitosauridae, where I provisionally place it.

The narrowness of the palate and the reduced parasphenoid, markedly elevated where broken, are strong arguments for an affinity to the Trematosauridae, but consideration of the regional development excludes it from this family. In general proportions there is a resemblance to *Mastodonsaurus acuminatus* Fraas, which I believe is superficial, however, for it is very unlike other genera and species of this family.

The more uniform generic characters among the Metoposauridae immediately exclude it from association in this family.

The impressions indicate an elongated skull nearly twice as long as broad with slender parasphenoid, elongated narrow palatal vacuities and, if I interpret the second fragment correctly, with orbits far back. Sutures are not indicated on this mold except those between the vomers and parasphenoid.

THE PARASPHENOID.—Is a narrow bar that extends forward in a narrow processus cultriformis terminating at the depressed pit 2 c.m. back of the transvomerine teeth. Anteriorly it unites with the vomers a distance equal to nearly one-half the length preserved. Its palatal surface is flat with lateral margins thickened posteriorly, indicating a wide endocranial groove as in *Trematosaurus brauni*. Posteriorly it rises considerably above the plane of the palate from which I infer a skull deeper than *Buettneria*.

The palatines and ectopterygoids are relatively broader than in other described forms available for comparison, excepting in the Capitosauridae.

TEETH.—At least 100 teeth and spaces can be counted on the combined maxillary and premaxillary of each side, and 50 in each combined palatine and ectopterygoid row. They increase in size gradually toward the front but without indication of greatly enlarged teeth in the extreme front. Apparently the bases were compressed anteroposteriorly. On each palatine and vomer there were two relatively large tusks alternately functioning, and the vomerine tusks at least were directed backward as in *Mastodonsaurus*. The row of transvomerine teeth were larger than those on the inner border of the internal nares, but shape or number cannot be determined.

PALATE OPENINGS.—The palatine vacuities are large, elongated openings unusually reduced in width by the narrowness of the skull and the relatively increased expansion of the pterygoids and palatines. The posterior nares are narrow, their width equaling one-third their length. The premaxillary openings are obscure, but they were probably confluent as in *Cyclotosaurus*, as there is no indication of a premaxillary bridge.

MEASUREMENTS.—Length of palate anterior border to last maxillary tooth in straight line, 24 c.m. Width of palate at last maxillary tooth, 7 c.m.

Stegocephalia that conform nearest in general development are from the Lower and Middle Triassic of other continents.

